DALLA CONOSCENZA ALLA VALORIZZAZIONE:
IL RUOLO DELL'ARCHEOMETRIA NEI MUSEI

ASSOCIAZIONE ITALIANA DI ARCHEOMETRIA
CONVEGNO TEMATICO

MUSEO ARCHEOLOGICO NAZIONALE

REGGIO CALABRIA

27 – 29 MARZO 2019

ASSOCIAZIONE ITALIANA DI ARCHEOMETRIA

museo archeologico nazionale reggio calabria

IPCF Istituto per i Processi Chimico Fisici

Carissimi,

Il convegno AIAr 2019, avrà luogo all'interno della splendida cornice del Museo Archeologico Nazionale di Reggio Calabria, recentemente inserito tra i cinque Musei di arte antica più belli ed entusiasmanti d'Italia. Obiettivo del convegno è promuovere il confronto fra ricercatori, studiosi ed operatori che lavorano nel campo della ricerca per i Beni Culturali, focalizzando l'attenzione sulle nuove tecnologie, i materiali innovativi e le strategie adottate per la diagnostica e la conservazione dei beni conservati ed esposti in ambito museale.

E'anche la prima volta che un convegno AIAr esce dalle accademie e dagli istituti preposti alla ricerca per spostarsi all'interno di un Museo determinando in qualche modo un'inversione di punto di vista.

Come ogni evento che l'AIAr, ormai da decenni propone, anche questo convegno vuole essere occasione per far risaltare l'importante ruolo che la divulgazione e la diffusione delle metodologie scientifiche applicate allo studio del patrimonio culturale possono giocare nella conoscenza, nella fruizione e nella valorizzazione del nostro patrimonio culturale.

Ulteriore momento di approfondimento sarà la tavola rotonda prevista per il 28 marzo dal titolo: ***L'archeometria: un valore aggiunto per la valorizzazione dei musei,*** *con la partecipazione di alcuni direttori di importanti strutture museali italiane e di scienziati e studiosi, nella quale saranno analizzate le migliori e più innovative strategie di valorizzazione dei numerosi reperti presenti nei musei, enfatizzando la necessità di lavorare in team multidisciplinari per raggiungere l'obiettivo di una maggiore fruizione del patrimonio culturale.*



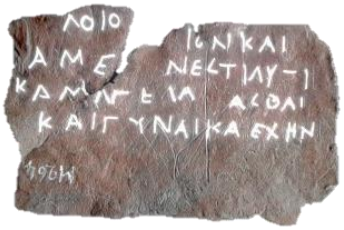

Benvenuti a tutti per un «tuffo» in Magna Grecia

Non solo Bronzi…

In evidenza al Museo

Durante le giornate del convegno sarà possibile non solo visitare ed apprezzare le sale del Museo Archeologico Nazionale ricche di testimonianze che forniscono uno spaccato straordinario della Magna Grecia, ma per una fortunata coincidenza anche una splendida e particolarissima mostra temporanea inaugurata qualche giorno fa. La mostra ***"Dodonaios. L'oracolo di Zeus e la Magna Grecia****" curata dal Direttore Malacrino, vede esposti oggetti di Dodona, sede del famoso oracolo, provenienti dalla collezione del Museo Archeologico di Ioannina, alcuni dei quali non avevano mai varcato prima i confini della Grecia.*

La mostra racconta la storia archeologica e letteraria del santuario dedicato a Zeus, di cui scrissero il tragediografo Euripide e lo storiografo Erodoto. L'oracolo era noto in tutte le città della Magna Grecia, tra cui molte in Calabria. I pellegrini si recavano al santuario da ogni parte dell'Epiro, della Tessaglia, dell'Attica, della Beozia, del Pelopponeso, della Magna Grecia, per interrogare la divinità per lo più su questioni personali in una pratica che durò molti secoli, dal VI al II a. C. almeno. La cosa più caratteristica e suggestiva è la modalità in cui ciò avveniva: in forma scritta, su laminette piccolissime, di pochi centimetri, che entrano sul palmo di una mano, con lettere incise delle dimensioni di pochi millimetri, che venivano piegate o arrotolate e presentate per la domanda (foto a sx). Un'occasione questa, forse unica per apprezzare pezzi di una collezione inusuale e straordinaria che conducono il visitatore in un affascinante viaggio alla scoperta del legame profondo e antico tra la nostra terra e la Grecia.



Comitato scientifico

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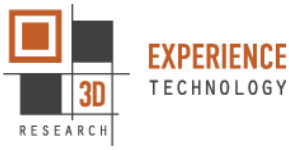

27 MARZO 2019

9.00	**REGISTRAZIONE**
11.30	SALUTI E APERTURA LAVORI
12.00	LECTURE INTRODUTTIVA – **CARMELO MALACRINO** DIRETTORE DEL MUSEO ARCHEOLOGICO DI REGGIO CALABRIA
13.00	**LIGHT LUNCH – TERRAZZA MUSEO**

14.20 – 16.40 SESSIONI ORALI PARALLELE

PIAZZA PAOLO ORSI – CARATTERIZZAZIONE E DIAGNOSTICA

Chairs: Mauro Francesco La Russa & Susanna Bracci

14.20	L. Pronti "In situ investigation and non-invasive diagnostics to support material analyses and restauration activities within the ADAMO project of the Technological District of Cultural Heritage-DTC Lazio"
14.40	M. F. Alberghina "The X-Rays imaging techniques for condition reporting of work of art involved in the temporary exhibitions"
15.00	A. Impallaria "Judith and Holofernes: reconstructing the history of a painting attributed to Artemisia Gentileschi"
15.20	F. Modugno "Investigation of painting technique in three paintings by Giuseppe Capogrossi at the Galleria Nazionale di Arte Moderna e Contemporanea (Rome)"
15.40	T. Cavaleri "Mapping Ancient Egypt black pigments through non-invasive analyses"
16.00	C. Caggiani "Building a spectroscopic palette of the early synthetic textile dyes"
16.20	C. Principe "Absolute dating of archaeological artifact: the furnace of Piazza Mercurio in Massa (Italy)"

SALA CONFERENZE – CONSERVAZIONE, MONITORAGGIO, RESTAURO; & MATERIALI DELL'ARTE CONTEMPORANEA

Chairs: Carmine Lubritto & Celestino Grifa

14.20	R. Manganelli del Fà "Diagnostic tools to preserve and enhance an archaeological site making it accessible to visitors: the case of Marino Mithraeum (Rome)"
14.40	A. Arcudi "The restoration of the St. Michael Archangel of Reggio Calabria: the contribution of technical analysis to its attribution"
15.00	P. Lucero "A sustainable strategy for microclimate characterization of museum environments for the preservation of traditional oil paintings"
15.20	L. Brizi "Portable Nuclear Magnetic Resonance: cultural heritage applications"
15.40	A. Spagnuolo "Climate and Cultural Heritage: the case study of "Real Sito di Carditello"
16.00	M. Fedi "^{14}C dating and contemporary art: the case study of Concrete Art"
16.20	F. Armetta "The mystery of "Tremiti plates wreck: insight on the nature of metal plates"

16.40 – **VISITA MUSEO**

17.30 – 19:45 – **BUFFET IN TERRAZZA**

28 MARZO 2019

9.00 – 11.00 SESSIONI ORALI PARALLELE

PIAZZA PAOLO ORSI – CARATTERIZZAZIONE E DIAGNOSTICA

Chairs: Maria Francesca Alberghina & Mauro Francesco La Russa

9.00	S. Raffiotta "Unveiling the colours of Morgantina. From knowledge through diagnostics to conservation, popularization and enhancement"
9.20	M. Ricca "The CRATI Project: new insights on the consolidation of salt weathered stone and the case study of San Domenico church in Cosenza (South Calabria, Italy)"
9.40	A. Aquino "The physical properties of the "Panchina" calcarenite from Livorno coast (western Tuscany, Italy)"
10.00	Y. Keheyan "Recent archaeometric investigations in Kotayk region (Solak-1/Varsak), Armenia"
10.20	C. Germinario "Tomba del Banchetto per l'Eternità in the Roman necropolis of Cuma: new insights on the polychromy and production technology of decorated walls"
10.40	C. Lubritto "The new archaeometric data support the latest archaeological hypothesizes about the painted slab tombs at Paestum"

SALA CONFERENZE – PROVENIENZA E DATAZIONE & TUTELA E VALORIZZAZIONE

Chairs: Maria Luisa Saladino & Eligio Daniele Castrizio

9.00	L. Lazzarini "IL KOUROS RITROVATO Preliminary studies for reassembling the two anatomical parts of the sculpture in Parian marble from Leontinoi"

9.20	G. Buccolieri “Diagnostic procedures before restoration of the statue of Sant'Oronzo and the Roman column in Lecce – Italy”
9.40	G. Mantella “Barbed male head, so-called "Head of Porticello" 460-450 BC”
10.00	R. De Luca “The SILPI project: a system for determining the provenance of Calabrian rocks by image analysis”
10.20	G. Fiocco “I Cantieri del Suono” project: a public-private cooperation for the valorization of the violin “Piccolo” by Lorenzo Storioni (1793)”
10.40	M. Romboni “Osteobiography of the people buried in La Sassa cave: an integrated bioarchaeological approach to deepen the knowledge of local Cultural Heritage”

11.00 – 11.30 **COFFEE BREAK – TERRAZZA MUSEO**
11.30 – 13.00 **TAVOLA ROTONDA** - *L’ARCHEOMETRIA UN VALORE AGGIUNTO PER LA VALORIZZAZIONE DEI MUSEI* MODERATORE **CARMINE LUBRITTO** (PRESIDENTE AIAR) SPEAKER CONFERMATI: **GINO MIROCLE CRISCI** (RETTORE UNICAL), **DANIELE MALFITANA** (DIRETTORE IBAM,CNR), **MENOTTI LUCCHETTA** (DIP. PRESIDENZA RICERCA SCIENTIFICA E INNOVAZIONE – REGIONE CALABRIA), **EVA DEGLI INNOCENTI** (DIRETTORE MARTA), **FRANCESCO TACCETTI** (COORDINATORE NAZIONALE INFN, CHNET), **CIRINO SALVATORE VASI** (DIRETTORE IPCF,CNR), **CATERINA DI GIACOMO** (DIRETTORE MUME), **CARMELO MALACRINO** (DIRETTORE MARRC)
13.00 – 14.20 **LIGHT LUNCH – TERRAZZA MUSEO**
14.20 – 15.20 **SESSIONE POSTER – TERRAZZA MUSEO**

15.20 – 16.40 SESSIONI ORALI PARALLELE

PIAZZA PAOLO ORSI – LA DIVULGAZIONE NEI BENI CULTURALI E LA DIFFUSIONE DELLA CULTURA SCIENTIFICA

Chairs: Vincenzo Barrile & Angela Quattrocchi

15.20	E. Ferraris "Invisible Archaeology: a new Museo Egizio exhibition about archaeometry and biography of objects"
15.40	L. M. Amadori "The return of Uomini illustri to Urbino: from scientific investigations to real and virtual exhibition"
16.00	A. Galli "MOBARTECH: a mobile, interactive and participatory platform for the study, conservation and promotion of Cultural Heritage"
16.20	N. Rovella "An innovative experience of dissemination: MAGNA project, on the route from Greece to Magna Graecia"

SALA CONFERENZE – CARATTERIZZAZIONE E DIAGNOSTICA - SPETTROSCOPIA

Chairs: Susanna Bracci & Maria Francesca Alberghina

15.20	A. Piccirillo "Through the surface: investigations from X-rays to NIR of two panels by Marco D'Oggiono"
15.40	A. Smeriglio "Archaeometric study of a unicum votive object"
16.00	D. Sali "New perspectives for Molecular Spectroscopy"
16.20	J.J. Lucejko "Comparative chemical investigations of alum treated archaeological wood from different museum collections"

16.40 – 17.10 **COFFEE BREAK – TERRAZZA MUSEO**

17.10 – 18.30 SESSIONI ORALI PARALLELE

PIAZZA PAOLO ORSI – CARATTERIZZAZIONE E DIAGNOSTICA -METALLI

Chairs: Sebastiano Trusso & Maria Luisa Saladino

17.10	S. Pafumi "Roman bronze statues in the Catania Civic Museum: new evidence from an archaeological and archaeometrical perspective"
17.30	R. Filosa "Non-Destructive Archeometric Investigation on Bronze Anthropomorphic Couples as Pendants"
17.50	L. Es Sebar "An in-situ corrosion monitoring campaign of Cor-ten structure exposed outdoor"
18.10	F. Grazzi "Historical metallurgy of Indian arms and armour made of wootz steel using neutron methods: a successful 10 years collaboration between neutron scientists and the museum conservation department of the Wallace Collection (London)"

SALA CONFERENZE – LABORATORI MOBILI ALL'INTERNO DEI MUSEI

Chairs: Simone Caglio & Alessio Toscano Raffa

17.10	D. Magrini "Revealing Mithras' color with the ICVBC Mobile lab in the Museum"
17.30	F. Albertin "X-ray Computed Tomography in situ: an opportunity for Museums and Restoration laboratories"
17.50	T. Auricchio "Mobile laboratories for restoration and diagnosis projects in museum sites"
18.10	S. Pasquale "ARCA 2.0: a Web-based framework for Automatic Munsell Color Characterization for Archaeology"

18.30 – **ASSEMBLEA DEI SOCI – PREMIO IMPROTA**

20.30 – **CENA SOCIALE**

29 Marzo 2019

9.00 – **Plenary Lecture** – Piazza Paolo Orsi

Costanza Miliani "The access to MOLAB advanced mobile analytical instrumentations: new opportunities for European researchers in Cultural Heritage"

10.00 – 11.00 Sessioni orali Parallele

Piazza Paolo Orsi – Caratterizzazione e Diagnostica

Chairs: Simone Caglio & Alessio Toscano Raffa

10.00	G. Lando "The mosaics of the Roman Domus of Villa San Pancrazio in Taormina (ME): iconographic, stylistic features and characterization of the elements"
10.20	M. Ricci "Comparison and integration of hyperspectral imaging and active thermography for the inspection of paintings"
10.40	C. Branca "A multitask study to discriminate natural, treated and synthetic emeralds"

Sala Conferenze – Conoscenza, valorizzazione e divulgazione del patrimonio sommerso

Chairs: Eugenio Caponetti & Maria Luisa Saladino

10.00	F. Bruno "H2020 i-MARECULTURE project: advanced virtual and augmented reality tools for improving accessibility of the underwater cultural heritage"
10.20	F. Aliotta: "A modular ROV/AUV for submarine investigation and monitoring"
10.40	L. Randazzo "The apsidal fishpond of Castrum Novum (Santa Marinella, Rome, Italy): preliminary archaeometric characterization for the MaTACoS Project"

11.00 – 11.30 **COFFEE BREAK – Terrazza Museo**

11.30 – 12.50 SESSIONI ORALI PARALLELE

PIAZZA PAOLO ORSI – DIGITALIZZAZIONE E RICOSTRUZIONE 3D

Chairs: Francesco Aliotta & Vincenzo Barrile

11.30	A. Toscano Raffa "Excavation of the Eastern Gate of Skotoussa, Thessaly (GR): Archaeological illustration and 3D rendering via laser scanner"
11.50	E. Donato & D. Giuffrida "Integrated survey methodologies for documentation and reconstruction of historical buildings: the Castel of Scalea (CS, Italy)"
12.10	M. Gargano "Use of RTI light interpolation for profilometry and 3D rendering of Cultural Heritage objects"
12.30	G. Armone "Virtual archaeology between disclosure and scientific research. The role of an expert in private companies"

SALA CONFERENZE – CARATTERIZZAZIONE E DIAGNOSTICA

Chairs: Carmine Lubritto & Mauro Francesco La Russa

11.30	I. Vacirca & L. Maniscalco "Archeometric analisys on hearth plates and combustion structures from Bronze age villages of Margi Valley"
11.50	S. Pacifico "Knowledge and extension perspectives of the Archaeological Museum of Positano between archeological excavations and restorations for the enhancement of the Roman Villa"
12.10	C. Grifa "Integrated Diagnostic Procedures on Yazılıkaya reliefs (Hattuša, Turkey)"
12.30	C. Gattuso "Cognitive methodology and diagnostic plan for cultural heritage conservation"

13.00 – **CONCLUSIONI – PREMIO MIGLIOR POSTER**

SESSIONE POSTER

P-1 E. Fiorenza, M. D'andrea, M. Musella, F. Sudano, A. Taliano Grasso, D. Barca: Geochemical characterization of glass tesserae in the Nereid Mosaic from Quartiere S. Aloe in Vibo Valentia- Calabria Italy

P-2 S. Raffiotta, M. F. Alberghina, S. Schiavone: Investigating colours on a Hellenistic Gnathia-ware pyxis with lid from Morgantina, Sicily

P-3 M. Cavalieri, C. Fornacelli, S. Bracci, M. Giamello, S. Landi, D. Manna: Opus Sectile Glass Fragments from the Roman Villa of Aiano-Torraccia di Chiusi (San Gimignano, Siena)

P-4 M. L. Saladino, V. Ciaramitaro, L. Ercoli, A. Spinella, E. Caponetti: Protection of the stone of the Temple G of Selinunte. Investigation of the interactions between the substrate and the protective

P-5 S. Caglio, A. Collina, M. Ferrari Trecate, C. Livio, F. Stringhetti: The Ico Parisi's palette: preliminary studies

P-6 R. Yivlialin, A. Sassella, L. Raimondo, A. Galli, M. Martini: Detecting the NIR fingerprint of colours: the characteristic response of blue pigments

P-7 M. Corradini, L. De Ferri, M. C. Caggiani, D. Manzini, G. Pojana: Characterization of powdered pigments for pictorial retouching by means of spectroscopic techniques

P-8 F. Giacobello, V. Mollica Nardo, C. Di Giacomo, G. Anastasio, M. L. Saladino, G. Lupò, M. F. Alberghina, S. Schiavone, F. Saija, R. C. Ponterio: San Gregorio polyptych of Antonello da Messina: a diagnostic campaign on the state of the artwork conservation

P-9 A. Furno, F. Cilenti, C. Germinario, C. Grifa, F. Izzo, M. Mercurio, A. Langella: Preliminary contribution on the conservation state of the domus domini imperatoris Apicii built by Frederick II along the Ancient Via Appia (southern Italy)

P-10 L. Guidorzi, A. Re, F. Picollo, F. Fantino, L. Martire, E. Belluso, G. Artioli, L. Peruzzo, S. Boesso, V. Rigato, L. La Torre, D. Carlucci, A. Lo Giudice: Ceramic forgeries aged by radiation: towards a new method for their identification

P-11 L. Longo, P. Ricci, N. Skakun, V. Terehina, G. Sorrentino, L. Vaccari, G. Birarda , N. Cefarin, L. Tortora, C. Cagnato, S. Covalenco, T. Obada, S. Altieri, C. Lubritto: “Stone tools as bioarchives” An integrated multi-scale contextual approach

P-12 C. Invernizzi, P. Targowski, M. Iwanicka, B. Blümich, C. Rehorn, M. Albano, G. Fiocco, T. Rovetta, M. Licchelli, D. Bersani, P.P. Lottici, M. Malagodi: Combining OCT and NMR-MOUSE techniques to study the stratigraphy of historical violins: the thickNESS project

P-13 M. Bertasa, C. Ricci, M. Gulmini, P. Croveri, D. Scalarone: Painting materials and decay phenomena in urban art: the case of the Urban Art Museum in Turin

P-14 A. Piccirillo, G. Ferraris di Celle, B. Ferrarato, D. Angelici, M. Borla, C. Greco, G. Racca, A. Re, A. Lo Giudice, P. Gallo, R. Boano, A. Valazza, M. Gulmini: Appearances are deceiving. The small mummy with coffin from the Museo Egizio in Torino (cat. 2247/2): many approaches to support its interpretation

P-15 F. Parrotta, S. Bonanno, V. Mollica Nardo, G. Anastasio, E. Caponetti, M. L. Saladino, C. S. Vasi, R. C. Ponterio: Spectroscopic and thermographic surveys in the church of S. Maria delle Palate di Tusa (ME)

P-16 V. Mollica Nardo, D. Giuffrida, V. Renda, M. A. Mastelloni, R. C. Ponterio: Raman characterization of clay masks at Archaeological Museum of Lipari

P-17 J. Keheyan, M. Aceto, G. Eliazianc: Scientific research supporting the study of pigments and dyes in Armenian miniature painting art

P-18 G. Sabatino, M. Di Bella, F. Italiano, M. A. Mastelloni, S. Quartieri, A. Tripodo, S. Tusa: Architectural elements from the Roman age harbor of Lipari Island (Aeolian Archipelago, Italy): petrographic evidences for the use of Fuardo stones

P-19 V. Renda, V. Mollica Nardo, S. Trusso, R. C. Ponterio: pH effects on SERS active substrates prepared by Pulsed Laser Deposition

P-20 M. T. Caccamo, D. Lombardo, S. Magazù: PEO-based nanostructured polymer systems as a cleaning agent of artworks

P-21 S. Ferrarese, D. Bertoni, M. Leone, M. Rinaudo: Microclimatic analysis in museum showcases

P-22 S. La Felice, T. Abebe, A. Aquino, S. Landi, M. Lezzerini, C. Principe: Geological and Cultural Heritage: dissemination experiences in Tuscany

P-23 M. Cardinali, L. Coniglio, A. Piccirillo, C. Ricci, S. Viel: Open for restoration. Conservation as experience and shared responsibility

P-24 A. Cammalleri: "Cromlech"" photogrammetric digital modeling of Passo Mandarini, Petralia Soprana (PA)

P-25 D. Giuffrida, V. Mollica Nardo, M. A. Mastelloni, O. Adinolfi, R. C. Ponterio: 3D survey and modeling of masks and calyx craters of Archaeological Museum of Lipari: integration of laser and photo scanning systems"

P-26 F. Maspero, A. Sassella, E. Sibilia, A. Galli, L. Panzeri, M. Martini: A virtual approach to historical scientific instruments

P-27 S. Bonanno, F. Parrotta, R. C. Ponterio, V. Barrile, A. Fotia, A. Nunnari: 3D laser scanner techniques for the enhancement and virtual fruition of cultural heritage: the Church of Sant'Antonio Abate (RC)

P-28 A. Aquino, E. Pecchioni, V. Moggi Cecchi, M. Lezzerini: The role of 3D modelling for different stone objects: from mineral to artefact

P-29 V. Barrile, A. Fotia, G. Candela: Geomatics techniques for cultural heritage dissemination in Augmented Reality: Bronzi di Riace case study

P-30 V. Barrile, A. Fotia, R. C. Ponterio, F. Aliotta: Submerged Heritage: Geomatics techniques and Augmented Reality

P-31 C. Malacrino, I. Vacirca, R. C. Ponterio, D. Giuffrida, S. Bonanno: Technologies at the service of promotion. 3D model, virtual restoration and augmented reality applied to MArRC’s collection

Codici

C&D = Caratterizzazione e Diagnostica

CMR = Conservazione, Monitoraggio, Restauro

DBC = La divulgazione nei beni culturali e la diffusione della cultura scientifica

DR = Digitalizzazione e Ricostruzione 3D

LM = Laboratori mobili all'interno dei Musei

PS = Conoscenza, valorizzazione e divulgazione del patrimonio sommerso

MC = Materiali dell'arte contemporanea

PD&TV = Provenienza e Datazione & Tutela e Valorizzazione

P = Poster

In situ investigation and non-invasive diagnostics to support material analyses and restauration activities within the ADAMO project of the Technological District of Cultural Heritage-DTC Lazio.

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In the last 30 years, Cultural Heritage has become one of the research line of many scientific disciplines (chemistry, physic, biology, etc.) due to the raising awareness that scientific approach gives a strong contribute to the knowledge of the employed materials and their degradation products, to authentication issues and to the development and monitoring of restauration treatments.
The scientific investigations applied on Cultural Heritage involve several analytical techniques using micro-destructive [1] and non-destructive methods [2]; these latter are preferred by historians and collectors since artworks must not be damaged due to their uniqueness and prestige. This restriction combined with the impossibility to move some objects have led to the development of portable instruments that allow to perform in situ measurements [3].
We present here a multidisciplinary approach with portable devices employed *in situ* for the characterization of pictorial surfaces and to support restoration activities within the ADAMO project of the Cultural Heritage Technological District - DTC Lazio. The aim of the project is transferring diagnostic technologies to the study of archaeological, historical and artistic works placed in the South-west of Rome in order to propose alternative tourist routes and to retrain Rome suburbs.
The aim of our work is to obtain almost complete scientific data from complementary techniques employed in two sites of interest of the ADAMO project: “Palazzo Chigi” (Ariccia) and “San Nicola in Carcere” Church (Rome). The set-up of portable instrumentation is composed by optical macro photography, reflectance spectroscopy, X-Ray Fluorescence Spectroscopy (XRF), multispectral imaging, infrared reflectography, Time Gated–Laser Induced Fluorescence (TG-LIF) and portable Fourier Transform Infrared (FT-IR) spectroscopy. The results will enrich the information on the “Palazzo Chigi” collection and will be a fundamental support during the restauration procedures of “San Nicola in Carcere” Church.

References

[1] Capobianco G., Bracciale M. P., Sali D., Sbardella F., Belloni P., Bonifazi G., Serranti S., Santarelli M. L., Cestelli Guidi M., Chemometrics approach to FT-IR hyperspectral imaging analysis of degradation products in artwork cross-section, Microchemical Journal 132 (2017): 69-76.
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Unveiling the colours of Morgantina. From knowledge through diagnostics to conservation, popularization and enhancement.

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The recent extraordinary spread of non-invasive methodologies to investigate cultural heritage has allowed scientists to focus their attention on polycromy in ancient art. It is a very fascinating topic, not very well known yet but interesting to appreciate the original appearance of many archaeological items that have lost their original colours. Studying pigments and painting techniques is today a matter of great interest not only for archaeologists and art historians but also for geologists, physicists, chemists, art conservators and restorers, making possible an effective cooperation among scholars specialized in many fields.

The paper aims to discuss the results of an ongoing multidisciplinary research project named "Morgantina a colori", focusing on polycromy in ancient Morgantina, a Sikel Greek settlement in central Sicily (Aidone, Enna). Thanks to more than sixty years of archaeological excavations carried out by an American archaeological mission, many findings (mainly terracotta statues and terracotta architectural ornamentation) with very well preserved original colours have been discovered in Morgantina.

Starting in 2014 with the cooperation of the Regional Archaeological Museum in Aidone (Enna), the project has recently proceeded thanks to the valuable help of CHNet - that's the INFN (Istituto Nazionale di Fisica Nucleare) Cultural Heritage Network - and the cooperation of "Polo Museale di Piazza Armerina, Aidone ed Enna" and "Centro Regionale per la Progettazione e il Restauro".

Through non-invasive analyses (XRF, XRD, Raman spectroscopy) a selection of archaeological findings from Morgantina has been analysed with the aim of detecting ancient pigments and techniques. The project is also intended to popularize and enhance the important role of polycromy in ancient Greek art between Archaism and Hellenism, allowing the general public of the archaeological museum of Aidone (where the polychrome items are on display) to discovery this currently mysterious topic.

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Judith and Holofernes: reconstructing the history of a painting attributed to Artemisia Gentileschi

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Recently, a new painting attributed to Artemisia Gentileschi, have been found in Ferrara, representing Judith exposing the head of Holofernes. Some analyses have been required to verify the history of this canvas, because another painting is known, which is very similar to this one, except for the heads of Judith and Holofernes. This last one has been attributed to the father of Artemisia, Orazio Gentileschi (Biscottin, 2011).

Judith and Holofernes, XVII century, oil on canvas, 97.5 x 133 cm, Ferrara, private collection

Many diagnostics have been performed, starting from imaging techniques, from the raking light, to UV fluorescence, IR-reflectography and X-ray radiography. All of them have highlighted peculiarities mainly about the head of the female protagonist. The results indicate that the face of Judith has been subjected to various reworks in the same artistic period because of the historic materials still present. This has given to it a peculiar fragility and for this reason restoration of 19th century has focused on this detail.

However, in this contribution we want to highlight the results obtained with XRF spot analysis. In fact, the artistic palette and the restoration materials have been fully characterised. For example, reds are in Cinnabar, but the Judith's lips have been restored with Cadmium Red, which gives an indication about the restoration period.

The more interesting results regard the use of Umber Earths. In this painting, this iron-based pigment rich of manganese has been revealed several times, and the correlation between Fe and Mn has been easily verified. Furthermore, more than one correlation has been found, deducing that more than one Umber have been used by the artist, even because of the use of this pigment (really superficial, so not attenuated by other materials) to darken the hues.

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Investigation of painting technique in three paintings by Giuseppe Capogrossi at the Galleria Nazionale di Arte Moderna e Contemporanea (Rome)

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The paint materials and techniques in several artworks by Giuseppe Capogrossi at the Galleria Nazionale di Arte Moderna e Contemporanea (Rome) were investigated in the framework of a joint project focused on the evaluation and the study of the conservation problems related to modern art, funded by the IPERION CH.IT platform. The object of the study were three *Superfici* painted by the artist between the 50s and 60s, a period in which the artist radically modified his paint techniques, introducing his iconic paint style.
From the 20th century, as a result of the scientific and technological industrial advancements, paint materials were produced on an industrial scale using new organic materials as ingredients as synthetic polymers, introduced since the 1950s, and additives. Modern paint formulations were in rapid evolution in the 1950s and 1960s, a period where oil paint coexisted with the availability of the first synthetic paint media, and the innovations in paint formulations are at the basis of specific conservation problems in modern art.
In order to define the best guidelines for the conservation of the works of arts, and identifying the less invasive approaches, we applied a set of analytical approaches based on non-invasive spectroscopy, and analysis of micro-samples. Analytical pyrolysis coupled with gas chromatography/mass spectrometry (Py-GC/MS), gas chromatography/mass spectrometry (GC/MS) and liquid chromatography coupled with high resolution mass spectrometry (HPLC-ESI-Q-ToF) were applied to obtain information on the chemical composition of the paint binders and on other organic components of the paint. The results obtained with the different analytical approaches were compared for the three investigated artworks, and with the archival information available on the artist, highlighting how his painting technique entailed the use of different paint media[1].

[1] This interdisciplinary project also saw the participation of other professionals in the field of diagnostics applied to Cultural Heritage, such as: S. Barcelli, DiSPeA, University of Urbino; M. Colapietro, Institute of Cristallography, CNR of Rome; V. Di Tullio, Institute of Chemical Methodologies, CNR of Rome; N. Proietti, Institute of Chemical Methodologies, CNR of Rome; M.P Sammartino, Chemistry Department, University of Rome "La Sapienza"; O. Tarquini, Institute of Cristallography, CNR of Rome; P. Triolo, DiSPeA, University of Urbino, that we thank for the work done.

Mapping Ancient Egypt black pigments through non-invasive analyses

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On February 15th, 1906, in a valley next to the village of Deir el-Medina, the Italian archaeological mission discovered the intact grave goods of two high-ranking individuals, the "director of works" Kha and his wife Merit. That discovery represents still today the most abundant and most complete non-royal burial assemblage ever found in Egypt. The objects found in the tomb, now exhibited in a dedicated hall of the Museo Egizio in Turin, have recently become the subject of an ongoing interdisciplinary research (TT8 Project) aimed at shedding new light on the materials used in the New Kingdom, the techniques of execution and the state of preservation of the various artefacts.

The wooden polychrome casket (S.08212), with geometric decorations and a figured scene, showed important results concerning the use of black pigments. Two different materials were mapped with the combination of IR reflectography (1400-1700 nm) and a MA-XRF real-time imaging spectroscopy [Romano et al. 2017]: carbon black and manganese-based black pigment. At the best of our knowledge, few references report about the use of manganese black in Ancient Egypt, with no specification about the technique of execution correlated to the use of this pigment [Lucas 1962; Nicholson 2000]. Preliminary results showed that the presence of manganese on this casket seems to correspond to very subtle details, as a finishing touch to complete first-setting profiles made with carbon black. Thus, the big issue is to understand if the manganese black was used preferentially, or combined with carbon black purposely due to specific reasons, perhaps technological.

To answer this question, it is necessary to acquire scientific data on several artefacts, verifying the use of the two pigments, and, in case of presence of manganese, considering both the technical behaviour of the material and the meaning to be associated with its use (e. g. for emphasizing decorative parts with a symbolic function, or for a revision of the hieroglyphs by a more expert hand).

Taking into account the spectral response of manganese black (pyrolusite) in the near infrared range, we tested a new method for improving the mapping and then the discrimination of the two pigments. Carbon black has a broad absorption band in the UV-Vis and in most of the IR region, whereas the manganese black starts to reflect from about 1000 nm. The maximum difference between the two is then in the 1400-1700 nm band. For this reason, an InGaAs camera was used with a 1400 nm interferential long pass filter. The resulting image was used to obtain an IR false colour image allowing to distinguish the different spectral features of the two materials.

The combination of the two techniques, InGaAs (nm) and MA-XRF seems to be an effective protocol for mapping the presence of manganese black on archaeological finds.

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Building a spectroscopic palette of the early synthetic textile dyes

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This work is part of a wider project aimed to the revaluation of the heritage belonging to the *Commodity Science Museum* of the University of Bari Aldo Moro, which owns a rare collection of pattern books produced by the German *Cassella Color Company* in early 20th century, varying from *Diamine Colors* on semi-wool and on semi-silk to *Immedial Colors* on cotton, to the dyeing of straw. The *Cassella Color Company* was founded at Frankfurt am Main (Germany) by Leopold Cassella in 1789. Initially devoted to the import-export of various products, among which dyestuff, it started its own manufacture towards the end of the 19th century thanks to the fusion with the dye factory founded by Frederich and Leo Gans at Mainkur, thus becoming one of the major worldwide synthetic dyes producers at the beginning of the 20th century [Aftalion 1991]. Between 1896 and 1905 the company published several pattern books describing the developing of dyes and dyeing processes of various textiles such as silk, cotton, linen and wool: they contained also representative fragments of fabrics colored with the synthesized dyes, actually constituting a valuable set of reference samples provided with the description and percentage of each applied dye. This work specifically aims to the scientific cataloguing of above-mentioned pattern books by means of non-invasive spectroscopic investigation.
Fiber Optics Reflectance Spectroscopy (FORS) has previously been tested for the identification of textile dyestuff, highlighting its benefits and drawbacks [Gulmini et al. 2013], notwithstanding it was mainly applied to the revelation of natural/traditional dyes in fabrics, being up to now the objects of study mostly prior to the era of synthetic colours [Angelini et al. 2010, de Ferri et al. 2018]. The main aim is to employ these precious sample sets as references for future characterizations of the 20th century textiles, being the turn of the century such an essential moment in the history of synthetic dyes.

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Absolute dating of archaeological artifact: the furnace of Piazza Mercurio in Massa (Italy)

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This presentation deals with an application of the archaeomagnetic method to dating of archaeological artifacts.

Following the standard procedure as described in Malfatti et al., 2011, a total of 24 samples (8x8x4 cm sized) of baked clays of the inner wall of a large furnace founded in Piazza Mercurio archeological site in Massa city (Tuscany) were collected. Prior to final removal, a large horizontal plaster cap were made on the top of each sample in order to be able to orient them using a solar compass.

Samples were subsequently plastered in squared molds at Archeo_Lab laboratory of IGG-CNR in Viareggio (Italy). The archaeomagnetic directional measurements (Declination and Inclination) were performed with the large cell induction magnetometer available at the IPGP Laboratoire de Geomagnetisme in Saint Maur des Fossés (Paris, France) and the twin magnetometer available at the Archeo_Lab laboratory of IGG-CNR in Viareggio (LU, Italy), according to a well-established experimental procedure (see Tanguy et al., 2003 for additional details).

The measurements in the magnetometer were performed in three different stages. The first series of measurements are performed after storing samples for a fixed time oriented along the same direction they were in situ. Later, the samples are stored for a fixed time reversing 180° respect the original orientation and a second series of measurement were performed. In this way the viscous remanent magnetization can be estimated. Mean viscous remanent magnetization resulted as low as 2.7%. The final stage of the analyses involves a gradual demagnetization in alternating magnetic field (AF), with the application of field steps of 25 mT and after each step the measurement in magnetometer are carried out. Mean directional data resulted in a Declination of 2.8° and an Inclination of 64.9°. The Fisher (1953) statistic parameters K and α95 are 636 and 1.13 respectively. No one of the 24 sampled specimens has been discarded, as no one was in the discard conditions requested by McFadden (1982) statistical procedure. For all samples, a stable and single palaeomagnetic component was retrieved.

The archaeomagnetic data produced for the Piazza Mercurio structure were compared with a suitable Reference Geomagnetic Secular Variation Curve (SVC) to obtain an absolute age. Recently, many updated directional SVCs were proposed for Europe. To obtained a reliable age for the Piazza Mercurio furnace we uses the SVC model SCHA.DIF.3K proposed by Pavòn-Carrasco et al. (2011). The SVC model used was specifically generated for the interval between 1000 BC and 2000 AD. The resulting age deal between 505 and 597 AD, dating this huge furnace to the end of the Late Antique Period.

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The X-Rays imaging techniques for condition reporting of work of art involved in the temporary exhibitions

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Non-invasive investigation techniques should today represent a fundamental contribution to the filling out the condition reports of the work of arts involved in the temporary exhibitions. The analyses carried out before and after the movement, allow to collect objective data to define the state of conservation and monitoring the surface or structural alterations, besides representing an important moment of deepening of knowledge. Generally, these aspects often are left to photographic documentation and observations by conservators and curators. An example of good practice is represented by the case of the Saint Gregory Polyptych (Antonello da Messina, 1473) belonging to the Regional Museum of Messina (Sicily). This artwork, constituting by five wooden panels [*Madonna and Child*, 129×77 cm; *San Gregorio and San Benedetto*, 125×63 cm; *Announcing Angel* 65 × 62 cm, and *Announced Virgin*, 65 × 55 cm] has recently undergone to non-invasive investigations aimed to evaluate the conservation state of the wooden support and the pictorial layers before the moving to the temporary exhibition "Antonello da Messina" (Palazzo Abatellis, 14 December 2018- 10 February 2019). X-Ray Radiography imaging (XRR) has been carried out *in situ* aimed to support the planning of the needed conservative actions to move the precious panels. Subsequently, X-Rays Tomography technique (CT) has been performed in lab to complete a deepen study of the supports, supplementing the first step of the non-invasive diagnostic analyses. In-situ radiography provided a preliminary evaluation of the connections between the original supports and the wooden or metallic elements added during the previous restoration works. Fractures, joints, nails, screws or grafts have been localized; original or restoration materials (including for example stuccoes in the thickness of the support) have been distinguished thanks to the different radiopacity. In these cases, the instrumental choice of a direct digital portable equipment (VIVIX-S 1417N Multi-purpose Portable Flat Panel Detector for Digital Radiography, 35.8×43.0 cm) allowed to instantly visualize the image, evaluating the acquired data quality, reducing the in-situ operations time and optimizing the set-up parameters and information reading of the 32 plate positions. The XRR data have been deepened and contextualized along the thickness of the wooden panels through the CT examination (TCMS Philips Brilliance 64), which has allowed to document the real paths and dimensions of the xylophagous insects' galleries, the orientation and the size of the fractures, the thickness of the joints, the size and inclination of nails and screws, the state of conservation of the wooden surface at the support-preparation interface and the different wood species constituting the supports. Thanks to the integration of the two techniques, a fully documentation has been obtained, retracing the complex structure of overlaps due to historical events and several past restorations [in particular: Cavenaghi,1915 (after the 1908 earthquake damages); ICR, 1942]. Finally, typical features of Antonello's execution technique have been highlighted, crossing the new evidence with knowledge on its *modus operandi*, widely documented during a previous diagnostic campaign (Poldi, Villa; 2006). Details regarding the mixture's heterogeneity, the layers application thicknesses, the glazes, the lead-white highlights the *chiaroscuro*, and the different underdrawing techniques have been revealed.

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The CRATI Project: new insights on the consolidation of salt weathered stone and the case study of San Domenico church in Cosenza (South Calabria, Italy)

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This paper presents the results of a laboratory experimentation carried out on natural stone in the framework of the CRATI project - *Knowledge and Restoration through Advanced Integrated Technologies* -, aimed at testing new products with consolidating properties by means of new methodological approach.
One of the activities within the project was devoted to the formulation and testing of products for the conservation of stone materials against weathering, especially salt crystallization which is the most aggressive degrading agent on stone materials. San Domenico church in the old town of Cosenza (South Calabria, Italy) has been chosen as pilot site and for the *in situ* tests.
Several specimens, collected from a historical quarry near the city of Cosenza, were first treated and then artificially degraded by salt crystallization tests in order to evaluate susceptibility to weathering. Three different consolidating products were used; respectively, two commercial ones and another synthesized in laboratory: a) a suspension of nanosilica (Nano Estel®), b) a suspension of nanolime (CaLoSiL®) and c) a suspension of nano calcium-hydroxide dispersed in isopropyl alcohol and then mixed with diammonium phosphate.
A systematic approach, including colorimetric test, contact angle measurements, peeling tests and point load test, was used to evaluate the efficacy of treatments as well as the resistance of treated stone to salt crystallization phenomena.
The experimented products demonstrated a significant efficiency to consolidate and protect stone material samples enhancing their properties of hydrophobicity and resistance to salt crystallization.
Such study may be useful to plan appropriate restoration interventions considering the interactions between the stone material and the protective/consolidating product.

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The physical properties of the "Panchina" calcarenite from Livorno coast (western Tuscany, Italy)

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The "Panchina" stone is a calcarenite, highly porous with medium sized grains reach in organogenic calcareous fragments mainly consisting in shells of bivalves, gastropods and echinoderms visible to the naked eye or by using a lens. This stone widely outcrops on the Tuscan coastline from Livorno to Rosignano Marittimo (western Tuscany) (Bartoletti et al., 1985; Lezzerini, 2005; Fratini et al., 2014). The high porosity that characterize the "Panchina" makes it very easy to work, explaining is extensive use in the area. While the weathering appears to improve its cohesion and resistance this material is sensitive to frost, which luckily is not an important factor in the climate of Livorno (Franzini 1993). In the framework of ongoing research on the building stones and mortars used throughout the Middle Ages in the Pisa's city (western Tuscany), this study focuses on the determination of the main physical properties (e.g. real density and apparent density, and total and open porosity – EN 1936:2007, water adsorption by capillarity - EN 1925:1999, water absorption at atmospheric pressure - EN 13755:2008, thermal and hydric expansion coefficients, EN 14581:2005) of "Panchina" stone samples from Livorno coast (Tuscany, Italy). "Panchina" is no longer quarried (Fratini et al., 2014), data is collected on unweathered materials sampled from inactive quarries.

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Recent archaeometric investigations in Kotayk region (Solak-1/Varsak), Armenia

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Recent archaeological investigations in Kotayk region (Armenia) by a joint Armenian–Italian expedition (IAE NAS RA and ISMEO), has brought to the identification in 2013 of one of the key sites of the region. Indeed, Solak-1/Varsak, a 16 ha site, shows the presence of a relevant Iron Age occupation with structures that can be attributed with certainty to the Urartian State. The fortress, currently under excavation, was contemporary a road station on the path that joint Ararat Valley and Sevan lake basin and the administrative centre of the middle valley of Hrazdan river. The chronology of the fortress was established thanks to its very peculiar architectural features, the presence of characteristic Urartian pottery and radiocarbon date. In 2016, a group of selected sherds dated to different periods (Iron Age and Middle Age) were brought in Italy for analysis. The microstructure and chemical composition of pottery, as well as pigments, has been intensively investigated using different techniques, like optical microscopy (OM), scanning electron microscopy combined with energy dispersive spectrometry (SEM-EDS), Fourier Transform Infrared spectroscopy (FTIR), X-ray diffraction (XRD). The stratigraphic analyses have shown different formations and morphology. Ceramic fragments are rich of precious elements: titanium, silver, aluminium, magnesium, iron etc. Micro-chemical and micro-structural studies of the samples have allowed further insight into the sources of the starting materials. This study project will be developed in close collaboration with the Regional Museum of Hrazdan, with which there is a lasting and fruitful collaboration, aimed at the enhancement and study of the important collections stored in it. One of the aim of this collaboration will be the creation of illustrative panels for visitors, in which there will be also archaeometric data next to the morphological and chronological information.

Tomba del Banchetto per l'Eternità in the Roman necropolis of Cuma: new insights on the polychromy and production technology of decorated walls

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The city of Cuma represents the most ancient Greek colony of the western Mediterranean Sea, studied since 1994 from the archaeological *équipe* of Centre Jean Bérard, in collaboration with other Italian Institutions. The excavations carried out in the northeast side of the city unearthed a monumental Roman necropolis with funerary mausoleums, tombs and isolated enclosures. Recent surveys performed in 2018 revealed the presence of the tomb MSL73101 (*Tomba del Banchetto per l'Eternità*; end of 2nd - first half of the 1st century b.C.), a hypogeum chamber tomb with vaulted ceiling built with tuff blocks.

The tomb was decorated with a banquet scene; the lunette of the southern wall reported a scene with a banquet preparation whereas landscape depictions with a floral frieze in the upper part decorate the side walls. The vault, also decorated, is painted in yellow and pink colours while the walls below the *cornice* are characterised by an intense red. In the tomb three funerary beds were preserved along with a table, reproducing a sort of triclinium.

The exceptional nature of the discovery is due to the peculiar decorative scheme, representing one of the rare coeval examples of figurative representations both in domestic and funerary contexts. Despite the evidences of a past plundering, the architectural scheme and the refined representations suggest the high social level of the dead, offering important cues for the reconstruction and the artistic evolution of the Cuman paintings.

In-situ non-destructive analyses and samplings of mortar fragments were performed in order to define:
a) the type of pigments used for decorating the tomb; b) the production technology of wall paintings and mortar-based support.

Multispectral images, Fourier Transform Infrared Spectroscopy and Raman spectroscopy performed on frescoes samples allowed defining the composition of pigments used for painting the tomb. Red ochre, hematite, yellow ochre, kaolinite, carbon black and calcite were recognised by using a no-destructive approach as principal types of pigments. Moreover, vibrational spectroscopy disclosed the composition of the underlying support, made of lime-based plasters.

In order to better understand their production technology, minero-petrographic analysis (Polarised Light Microscopy -PLM-, Scanning Electron Microscopy -SEM- and Energy Dispersive Spectroscopy EDS-) were also performed on plasters fragments, highlighting a multi-layer technology.

In the lower part of the walls, lime mortars with *cocciopesto* adhere on the tuff blocks (*rinzaffo/arriccio* layers) or constitute the *intonachino* layer, likely due to the good hydraulic properties of such a type of mortars in humid and wet environments.

On the other hand, the upper part of walls *arriccio* is absent or was not sampled whereas a thick and white *intonachino* layer constituted by lime binder containing sporadic grains constitutes the support of preparatory and painting layer.

On the vault, multi-layered plasters consisted of a thinner grey *arriccio* layer (ca. 0.5 cm), made with lime binder and fine volcanic sand as aggregate, covered by a white *intonachino* layer with rare calcareous grains, overlaid by the preparatory and pictorial layer.

The new archaeometric data support the latest archaeological hypothesizes about the painted slab tombs at Paestum

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Starting from the new archaeological suggestions about "Tomb of the Diver" exposed at the Archaeological Museum of Paestum (Capaccio, Salerno) and the understanding of its possible provenance context, an interdisciplinary team constituted by AIAr research groups promoted an archaeometric study of this famous artwork for deeply studying its technological features and then performing a comparison with other representative painted slab tombs coming from Hellenistic and Lucan necropolis, exhibited at the museum or stored in the deposits.

The research project aimed at identifying the original materials and the executive techniques involving the following finds: the "Tomb of the Palmettes" from Arcioni necropolis; T314 and T210 from Gaudo necropolis; T6, T23, T21, T76, T20, T11, T12 from Andriuolo necropolis and T109 and T110 from Santa Venera necropolis. For comparison, mortar fragments from polychrome layers of the Neptune and Basilica temples were also sampled. The multi-analytical investigation has been preliminary based on a non-destructive approach, performed *in-situ* by portable equipment (VIL, UV fluorescence, IR reflectography, FORS, ER-FTIR, Raman, XRF spectroscopy techniques); subsequently, a further deepening on micro fragments of representative samples by means of micro-invasive laboratory investigations (PLM, SEM-EDS, ATR-FTIR, TG/DSC -FTIR-EGA) has also been performed.

The research activities provided integrated useful results for: a) understanding the executive technique, (underdrawings, *pentimenti* or pictorial layers application sequence); b) localizing previous restoration (retouching, protective and/or consolidating materials); c) evaluating the conservation state of the painted surfaces; d) identifying pigments or dyes (original and due to previous restoration); and e) characterizing the organic materials (any original binders or recent restoration products). Moreover, the cross-section analyses shed light on the stratigraphic structure (from pictorial to preparation layers and supports) and mineralogical composition of samples, allowing inferring the production technology of the mortars used for the execution of the painted slabs.

The data were also processed through multivariate statistical analysis in order to highlight correlations among the different investigated finds and evaluate differences and similarities based on used materials, so as to provide objective support for the archaeological and historical-stylistic comparison of the investigated painted tombs. In particular, the analytical evidences highlighted significant similarities between the Tomb of the Diver and the Tomb of the Palmettes, already considered similar from a stylistic point of view.

Through the surface: investigations from X-rays to NIR of two panels by Marco D'Oggiono

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Marco D'Oggiono was mainly active at the Duchy of Milano (Italy) and worked at the workshop of Leonardo da Vinci, as documented by an autograph manuscript dated 1490 by Leonardo himself. The two panels considered here were originally part of a large polyptych, (the so called "Polittico di Maleo) consisting of ten panels painted for the Franciscan convent of Santa Maria delle Grazie in Maleo (Lodi, Italy). They were originally placed in the lower register and represent St. Francis and St. Anthony of Padua, each of them presenting a devotee. The panels are among the five ones still known of the original Altarpiece and are stored at the Pinacoteca di Brera in Milano. They have been studied and conserved during the activities related to a Master degree thesis in Conservation and Restoration of Cultural Heritage at the University of Torino – SUSCOR (in agreement with Centro Conservazione Restauro "La Venaria Reale"), and within this frame a set of scientific approaches has been employed in order to characterise the existing materials and to investigate D'Oggiono's painting technique.
A new transportable apparatus for macro-X-ray fluorescence[1] and an innovative compact VNIR hyperspectral camera[2] have been used to detail some specific parts of the panels. In particular, the attention has been focussed on areas in which the X-ray radiography suggested the possible presence of re-painted areas, highlighting changes compared to the first pictorial setting.
The performance of the two imaging techniques, each exploiting a different range of the electromagnetic spectrum, are discussed in the context of the other scientific analysis, focussing on their ability in recovering hidden information through the painted surface. The distribution of specific pigments could be detected by both the techniques, revealing the older pictorial treatment laying under the visible surface.
As the next step, the overall results of the scientific investigation will be combined with all the information recovered from many fields involved in the multidisciplinary investigation of the panels - from epigraphy to dress history through art history – in order to finally achieve an accurate interpretation of the paintings.

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Archaeometric study of a *unicum* votive object

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The "Timpone della Motta" archaeological site in Francavilla Marittima (CS) is considered one of the most important ones in Calabria. It includes three main areas: village, necropolis and sanctuary and it was frequented between the VIII and IV century BC. The investigated archaeological find has been excavated in the sanctuary area in a context datable to the VI century BC. To the best of our knowledge, similar objects were not reported in the specialized literature and, therefore, it can be considered a *unicum* whose function is unknown. The find context might, however, suggest that it is a votive dedication used by athletes as a belt weight or a fertility symbol offered by a woman.

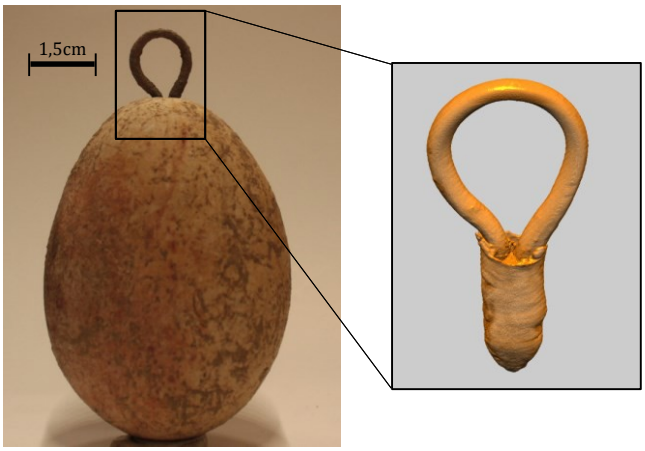
The aim of the current presentation is to determine the materials and the technological features of the object by means of non-destructive techniques. The object was investigated under an optical microscope in order to analyse the surface in search of decorations or refinement signs. The 3D reconstruction of the internal structure was recovered by applying X-ray microtomography at the μTomo experimental station of STAR_Lab - University of Calabria. Furthermore, the XRF spectroscopy was used to depict the nature of the constituent materials.

The results allowed us to determine that the object is a natural egg-shaped stone, on which no traces of refinement work have been found. The metallic ring at which the stone is anchored has two ends immersed in a hole on its more convex end. The 14mm-deep hole shape is clearly depicted by the tomographic reconstruction suggesting that it was produced by a manual drill. The tomographic sections show that the rings are held in place by an opaquer material inserted into the hole.

The Fluorescence results unveiled that the ring is a bronze alloy (Cu 93%, Sn 5%, Pb 1%, other elements 1%) while the filler was found to be a Pb (70%)/Sn (30%) alloy. The filler alloy is suitable for the use in the brazing technique due to its excellent wettability and good mechanical resistance.

At the present time, our hypothesis on the production process is that the bronze ring ends were inserted into the hole previously filled by the Pb-Sn alloy which in turn is kept fluid by heating the stone on open fire.

On the stone surface, we found areas with likely decoration traces of in different colours. Further investigations will be carried out to understand the nature of these coloured traces and compare them to the alternative interpretation as combustion-induced traces.



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New perspectives for Molecular Spectroscopy

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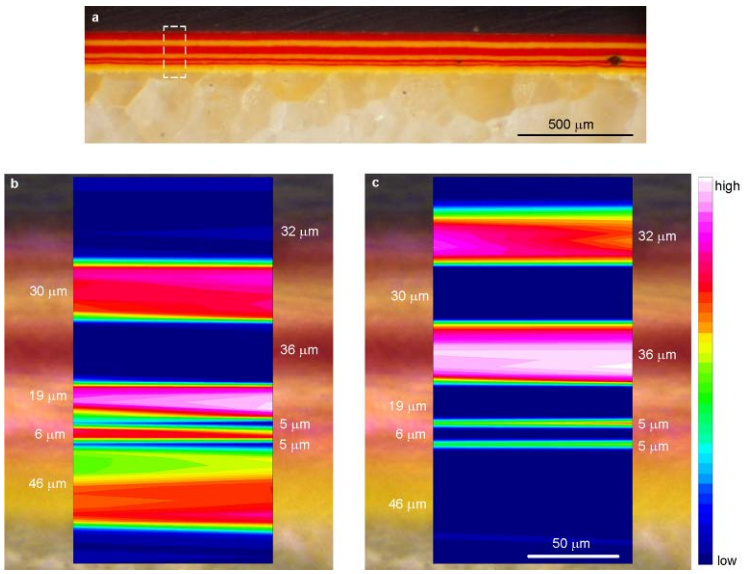
Molecular spectroscopy is an important analytical area with wide impact and extent. In this field, Raman and Infrared spectroscopies are powerful and complementary techniques, with an extensive use spanning from biomedical, pharmaceutical and material sciences, to name a few.
In last decades applications related to Art samples have become more and more demanding about several topics, like the possibility to perform *in situ* analysis of organics and inorganics in an easy way and with a non invasive and non destructive approach and the possibility to get precise information on micro-scale of layered materials when it is possible to have a sample to be analysed into the laboratory.
Moreover, the request to perform imaging in conjunction to the unambiguous molecular identification on micro and macro scale is continuously increasing.
Today all the latest technologies have been applied by Bruker to IR and Raman Spectrometers, both for portable and *in lab* instrumentations. So, latest innovations will be presented in terms of commercial products, with the state of the art compromise between sensitivity and effective usability. Lot of examples of real applications related to Art samples and to Cultural Heritage will be shown.



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Comparative chemical investigations of alum treated archaeological wood from different museum collections

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From the mid-1800 to the late 1950s, conservation by alum salts (potassium aluminium sulphate) – in various "recipes"- was a very popular method to prevent shrinkage and to impart strength to waterlogged wooden objects, mainly in Scandinavia and in Baltic States [1]. The alum method has been also used in other countries, for example in England and the U.S., but it was not so widespread [2]. The original method consisted in immersing the waterlogged wooden fragments in a concentrated solution of alum (potassium aluminium sulphate) at 90 °C. The salt penetrated into the surface of the wood and replaced the existing water. In 1911 George Rosenberg, modified the formulation by including glycerol [1]. In many cases the objects were coated with various types of oils, such as linseed oil, melted beeswax and shellac or nitrocellulose varnishes after treatment [1].
Today many of the wooden objects treated with alum feature an extreme deterioration and very low pH, conditions attributed to the effects of the alum-treatment and of the reactivity of alum [3,4].
The aim of this study was to investigate the extent of current chemical degradation in wooden objects conserved with alum salts in order to better understand the rate of degradation. We compared samples taken from four different collections treated at different points in time: the Dejbjerg collection (1883) from the National Museum of Denmark in Copenhagen; the Oseberg collection (1905-13), the Museum of Cultural History, Oslo, Norway; the Glimmingehus collection (1936), the Swedish History Museum, Sweden; and from the Colonial Williamsburg Foundation, Williamsburg, USA (ca 1950s or 1960s).
The samples were treated with alum using different recipes involving alum salts and other additives, such as linseed oil [5] and/or glycerol. To evaluate the chemical preservation state of the material, analyses of lignocellulosic polymers and of inorganic compounds present in the wood were undertaken. The investigations were performed using a multi analytical approach applying pH measurements, analytical pyrolysis (Py-GC/MS), X-ray diffraction (XRD), scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDS) and FTIR.

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Roman bronze statues in the Catania Civic Museum: new evidence from an archaeological and archaeometrical perspective

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Archival research and investigation into the storerooms of the Civic Museum of Catania have led to the rediscovery of fragments of bronze statues coming from the two most important local collections of the eighteenth century, one of the Prince of Biscari and the other one of the Benedictine monks. The fragments in Catania offers an important contribute to the understanding of large bronze statuary of the Roman period. A detailed examination has led to a more complete study of technical, typological and chronological aspects. In particular, a campaign of archaeometric analyses carried out with non-destructive methods has offered precise details of the composition of the alloy, offering also new elements to our understanding of the techniques of production and decoration.
This is the case, for instance, of an exceptional piece coming from the collection of antiquities of the Benedictines. It has been possible to establish that it was found in 1746, probably coming from ancient Anzio. The fragment belongs to a statue of large size, and consists of the edge of a cloak with an inlaid decoration, used to convey the impression of a textile enhanced by embroidered figures. The archaeometric examination of the inlay has demonstrated the use of an alloy that has been deliberately manipulated in its composition in order to obtain a very dark, almost black coloration with iridescence. These characteristics remember those of a specific alloy, used in Roman times and known throughout the Mediterranean as Corinthium aes,and those of the so called “black family” alloys.

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Non-Destructive Archeometric Investigation on Bronze Anthropomorphic Couples as Pendants

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Bronze pendants depicting anthropomorphic couples dating back to the 8th century BC were found in several Calabrian protohistoric sites. The historical-cultural context of the archaeological finds is associated with the Oenotrians, a population settled in southern Italy before the Greek colonization. We present the results of the investigation on two bronze pendants dating back to the early Iron Age: the first one, found in the course of archaeological surveys in the area of the Oenotrian necropolis of Pietrapaola (CS-Italy), is denominated as a couple "Type-A", of which 59 specimens are known, while the other pendant, found in Bucita di Rossano Calabro (CS-Italy), refers to a couple "Type-B", of which 4 findings are known.

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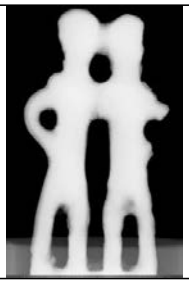
<tr><td>  </td><td>  </td><td>  </td><td>  </td></tr>
<tr><td>couple Type-A</td><td>X-ray projection</td><td>couple Type-B</td><td>X-ray projection</td></tr>
<tr><td colspan="2">Found in the archaeological site of Pietrapaola (CS)</td><td colspan="2">Found near Rossano (CS)</td></tr>
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The finds are preserved in the Laboratory of Ancient Topography and Calabrian Antiquities (LABTAAC) of the University of Calabria. The aim of this study is to understand the historical period, the construction technology, their use and the origin of these artefacts. We used two analysis technics non-destructive: X-ray microtomography (X-ray micro-CT) and X-ray fluorescence (XRF).

The X-ray micro-CT is playing an increasingly important role in the field of Cultural Heritage diagnostics. It represents a powerful non-destructive investigation technique, capable of displaying in a three-dimensional way the volume and the internal structure of the investigated objects. Furthermore, the XRF spectroscopy was used to identify of the chemical composition of "bronze" objects.

From a visual exam it's possible to deduce a difference between the two artefacts, for example the presence in the couple type-B of anatomic details well delineated while they are totally absent in the couple type-A pendant. The 3D reconstruction of the internal structure by X-ray micro-CT of bronze pendants highlights small fractures and voids. The fluorescence results obtained by a portable X-ray fluorescence spectrometer (pXRF) show a different composition of the bronze alloy: the superficial alterations caused by oxidation are also evident by the different manufactures surface colour.

Our hypothesis on the production techniques is that are casting from melt alloy in a form and after to use removal/addition techniques for modelling. In details, the couple Type-A shows: a) forms obtained by pouring molten metal into a mould, b) no anatomic details, c) small fractures but no voids. The couple Type-B was built using a more advanced technique of production: a) functional necklet hole, b) detailed anatomic features, c) presence of protrusions/additions (knees, arms, genitals, ...).

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An in-situ corrosion monitoring campaign of Cor-ten structure exposed outdoor

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The study of corrosion processes is a key issue in the field of Cultural Heritage: corrosion phenomena are certain to happen, mostly if a metal object is exposed to an outdoor environment. In several cases, corrosion phenomena lead to the formation of corrosion patinas of different chemical composition and colours. These patinas can be more or less protective and the protective effectiveness depends on the chemical composition and microstructure of the corrosion products layers and on the environmental conditions.
An interesting case is the one regarding weathering steels or high strength low alloy steels. As matter of fact, they form an adherent oxide barrier as they corrode under certain conditions, protecting the bulk from further corrosion phenomena. The corrosion products have a nice colour, that makes these materials suitable for the employment in the artistic and architectural field in outdoor conditions.
The long-lasting preservation of these works of outdoor art requires a project of tailored management, fruition and conservation strategies. To achieve this goal, an in situ monitoring campaign was conducted with a multi-analytical approach on the weathering steel structures of a residential building, known as 25-Green, a tree-house designed by the architect Luciano Pia and located in Torino (Italy) (1).
In particular, the corrosion processes occurring on the Cor-ten structures were investigated by means of in-situ electrochemical impedance spectroscopy (EIS). This technique is particularly interested because it gives information on the corrosion processes occurring and on the protective capability of the corrosion patinas. Information on the corrosion reactions that occur at the metal/patina interface are provided too.
The measurement setup was composed of a commercial electrochemical interface coupled with measuring probes, especially designed with a 3D print to be suitable for the field of Cultural Heritage. The measurements were carried out with a 0.1 M Na_2SO_4 solution, at the free corrosion potential (EOCP) by stimulating the sample with an alternating voltage in the range of 10-100 mV, in the frequency range 0.01-100 kHz.
Furthermore, µ-Raman spectroscopy was employed, together with Field Emission Scanning Electron microscopy (FESEM) and X-Ray powder diffraction (XRD) on corrosion patinas in order to correlate the chemical composition to the protective effectiveness.
In order to collect and display information on the conservation state of the pots installed in the structure through a 3D model, three-dimensional and texture data were collected thanks to photogrammetry measurements performed with a low-cost equipment.
The results of the monitoring campaign started in 2016 and still in progress will be presented and discussed.

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Historical metallurgy of Indian arms and armour made of wootz steel using neutron methods: a successful 10 years collaboration between neutron scientists and the museum conservation department of the Wallace Collection (London)

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The metallurgy of historic weapons such as swords is one of the most interesting topics in archaeometallurgy because these objects were manufactured, over the ages, using the highest quality materials and the most advanced technology [1-2]. The compositional and microstructural characterization of swords, particularly steel swords, can hence allow us to learn about the technological skills reached by different civilizations. The use of non-invasive techniques allows for the study of museum objects even in excellent conservation conditions, thus giving a clear view of their characteristics. Neutron imaging and neutron diffraction are, to the authors' knowledge, among the best methods to quantify phase composition and microstructure, study morphology, identifying non-metallic inclusions, cracks and defects [3-6]. An informal research collaboration is active since 2009 between the conservation department of the Wallace Collection and several research groups involved in the use of neutrons for materials research in the field of archaeometry.
Following this path, we have performed a number of experiments using neutron imaging and diffraction to non-destructively reveal the characteristics of many artifacts from different civilizations, of which the production procedures are not yet fully clear. In this work, we will concentrate in particular on the analysis of the micro-structural features of ancient Indian blades, carried out by neutron tomography and neutron diffraction. The results provide a clear identification of the different types of steel used to produce such weapons. Among them, only a small proportion of the large number of swords produced in India is made of hypereutectoid textured steel, namely wootz steel also known as "Damascus steel". The others present characteristics very similar to the European swords produced in the same period including composite low and high carbon steel assembled together and the application of thermal treatments.
The ancient swords and daggers, provided by the Wallace Collection in London and other museums related to the collaboration network, were analyzed to know about production process. The results permitted to determine the correct conservation procedure for the different types of steel and identify peculiar features, which, in the future we intend to exploit for provenance attributions.

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The mosaics of the Roman Domus of Villa San Pancrazio in Taormina (ME): iconographic, stylistic features and characterization of the elements.

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This contribution deals with preliminary results from the study on the mosaics discovered at the Domus of the Roman age of Villa San Pancrazio in Taormina (ME), object of excavations since 2016 by the DiCam of the University of Messina, in collaboration with the CNR-IBAM of Catania and the Superintendency of Messina. The stratigraphic, stylistic and iconographic analysis of the floors was accompanied by the use of archaeometric techniques, carried out by the Department of Analytical Chemistry, University of the Basque Country and by the CHIBIOFARAM Department of the University of Messina. The aim is to define the issues linked to the composition, origin and supply of raw materials, to the study of production techniques and installation of the tesserae, probably to be attributed to local workers, the processes of conservation and degradation of the floors, after the abandonment of housing.
Preliminary archaeometric investigations on the tesserae have been carried out by means of a non-destructive analytical methodology. For the characterization, micro X-ray fluorescence (µ-XRF) analysis was employed to acquire semi-quantitative elemental data together with a combination of Raman spectroscopy and X-ray powder diffraction (XRD) that was used for the collection of molecular and structural information (Fig.1).

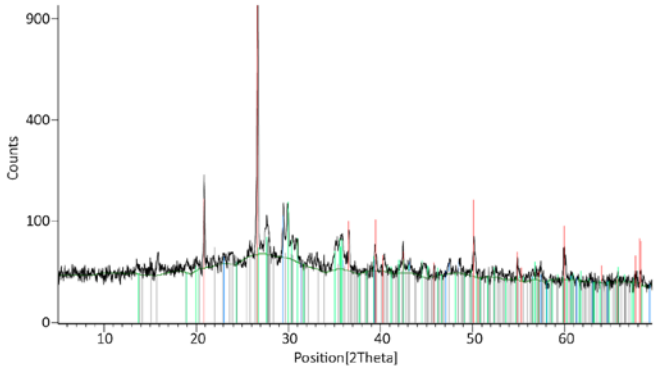

Figure 1. X-Ray diffraction results of a black tessera sample, in which diopside of the pyroxene group ($CaMgSi_2O_6$), nefeline ($NaAlSiO_4$) and leucite ($KAlSi_2O_6$) signals are identified in an estimated percentage of 32%, 26% and 42%, respectively.

In addition, the µ-XRF data of the black samples were analyzed by chemometric tools, to assess their volcanic nature and origin. The results of the black tesserae were compared to the elemental analysis of samples coming from Etna, Aeolian islands, Campi Flegrei, Vesuvio and Roman provinces reported in the book "Plio-quaternary Volcanism in Italy" by means of unsupervised Principal Component Analysis (PCA).

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Comparison and integration of hyperspectral imaging and active thermography for the inspection of paintings

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In paintings inspection, the use of non-destructive evaluation techniques relying on the analysis of the infrared (IR) response of the sample to suitable excitations can provide precious quantitative and qualitative information about the pictorial, preparatory and support layers. Among the various techniques available, Active Thermography (AT) in the middle-wave IR (MWIR) and Hyperspectral Imaging (HSI) in the short-wave IR (SWIR) complement each other perfectly. The latter is able to provide information about the composition of the painting layer in term of pigments, bindings, etc. and to evidence also characteristics of the preparatory drawing by exploiting the partial transparency of most of the pigments in the SWIR [1]; the former is suitable to inspect the whole 3D structure by analysing the painting thermal response recorded as time elapses via a thermal camera [2] allowing the detection of detachments, cracks and voids in the multi-layer structure, etc. AT allows time-domain analysis to inspect complex structures as the paintings are: this implies using high-power flash lamp (Pulsed-Thermography -PT) to ensure the needed the Signal-to-Noise Ratio (SNR). Nevertheless, it is important to avoid any thermal stress onto the painting surface and possible thermochromism to occur, thus the need to reduce the power of the employed heating source, though without reducing the Signal-to-Noise Ratio (SNR) and the inspection capability of PT. Recently, *S. Laureti et al* [3] proposed the use of coded excitations to modulate the emission of a low-power LED chips system (110W) in combination with the Pulse-Compression technique for painting inspection to gently spread the heat stimulus over time. This technique is referred as Pulse-Compression Thermography (PuCT), and it proved being able of assuring the inspection capability of PT, while not reducing and perhaps increasing the final SNR. The combined use of PuCT and HIS is here proposed for the inspection of a Botticelli's Venere mock-up, having embedded defects buried at different depths under the finishing layer, simulating either delamination or the so-called *pentimenti* (see Fig.1(a)). Two novelties are presented: (i) the use of Principal Component Analysis (PCA) on the PuCT output (see Fig.1(b)-(c)), and (ii) their fusion with results achieved by HSI. Results obtained via PuCT in the MWIR Fig.1(b-c) show clear evidence of defects, whilst *pentimenti* are visible in HSI data at 1480 nm. Enhanced contrast between *pentimenti* and painting layer is achieved in Fig.1(e) making use of PCA. Red markers are used in Fig.1(b-e) to highlight the defected areas. In the full paper, PCA will be implemented directly on the combined PuCT-HSI data to further optimize the information extraction process.

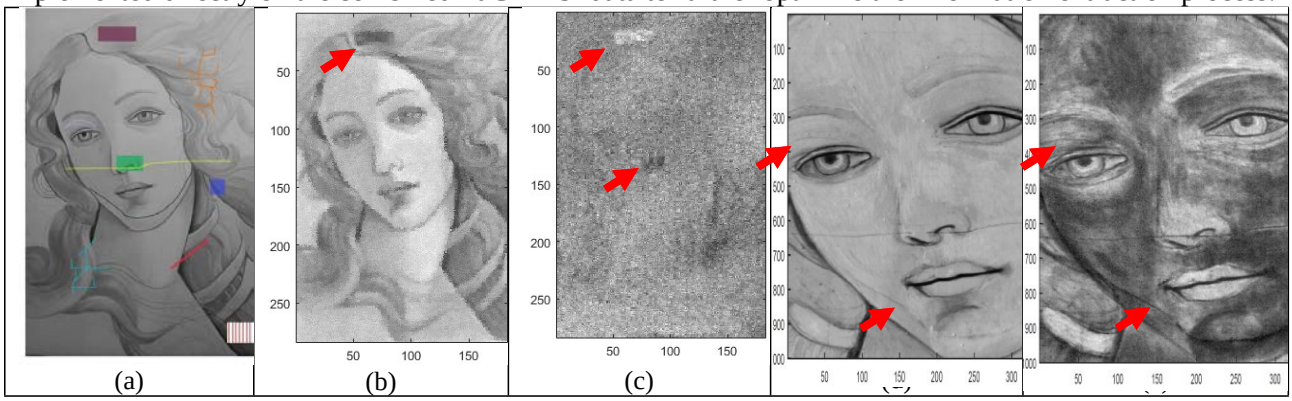

Fig.1: (a) Inspected painting with defects location; (b-c) PuCT PC1 and PC2 results; (d) Raw and PC1 hyperspectral data.

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A multitask study to discriminate natural, treated and synthetic emeralds

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A multi-methodological nondestructive investigation of a series of natural, synthetic and treated emeralds has been performed by means of confocal Raman microscopy, scanning electron microscopy (SEM)/energy dispersive X-ray (EDX), and Fourier transform infrared (ATR–FTIR) spectroscopy.
By systematically analyzing the differences in the Raman and infrared spectra and by correlating the spectroscopic parameters with the chemical composition of the investigated samples, we have developed a promising analytical protocol to unambiguously investigate solid mineral inclusions, determine the geographic origin of natural stone or the growth technique of a synthetic gem, discriminate natural from synthetic emeralds and detect and identify the emerald fillers and adulterated natural gemstones.

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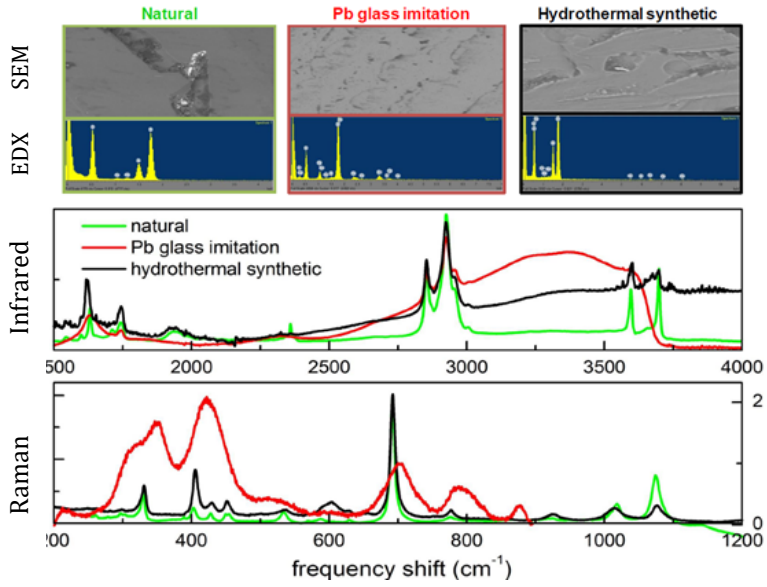

Archeometric analysis on hearth plates and combustion structures from Bronze age villages of Margi Valley

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In the ancient Bronze Age sites identified in the district between the Catania Piana and the Margi Valley, combustion structures have been found in domestic contexts. The sites that we will present are the villages of Santa Febronia, Camuti and Monte Catalfaro, where excavations have been conducted extensively allowing us to discover a great part of the villages. Another site is that of Rocchicella which provided the majority of the sample that have been subjected to archaeometric analysis.

Hearth plates, found in fragments both inside the huts and outside, provide fundamental data on the typology of functional areas and on domestic activities related to food preparation and cooking; these data are also confirmed by paleobotanical analysis.

The sites presented show a various and large series of combustion structures both from typological and structural sight and both for the relationship within the living units. Hearths on a plate, common inside the huts; a hearth with a sunken base and an oven, dating back to the Bronze Age, from Rocchicella, these are some of the typologies found in these sites.

Alongside these structures, there were also mobile artefacts such as braziers on foot and objects and other tools related to food preparation.

Starting from the study of the plates of the sites of R., the samples were subjected to X-ray refraction (XRF), Scanning electron microscopy and petrographic analysis to verify the different composition of clay components and the methods of realization for this specific class of structures in respect to the braziers on foot, from which these differs in strength and compactness of the clay composition.

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Knowledge and extension perspectives of the Archaeological Museum of Positano between archeological excavations and restorations for the enhancement of the Roman Villa

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In the past ten years, the combined effort of the Municipality of Positano and the Superintendence for Archaeological Fine Arts and Landscape of the province of Salerno and Avellino, has allowed to highlight a portion of the inestimable artistic value of the I century Roman Villa. Today the actual public institutions, thanks to the previous important experiences made during the latest works, have made a commitment for new perspective excavations and enhancement objectives of the Roman villa of Positano that will highlight the paradigmatic element of the ancient city. In this extension perspective we can consider the area of via Rampa Teglia where, during the latest works, an excavation site has been initiated that has needed the consolidation of the investigated area perimeter and the realization of a floor structure without intermediary supports that covers an area of 130 m². Today under the public area in issue, at a depth of approximately 5 meters, the roofs of the I century Roman villa have emerged, from which the painted walls in *opus reticulatum* with brick covering are beginning to come out. An archaeological area that is closely connected to the medieval hypogeum structures of the mother church, now hosts the exhibition layout of the new MAR Museo Archeologico Romano of Positano. The findings, so far, allow us to imagine the spaces where to reproduce the perspective of the ancient city of Positano thanks to the not easy excavations, precise consolidation interventions and neat restoration and musealization processes. The reaching of such objectives will be possible by means of a series of interventions that have a convergence and the effort of many professionals. It will be a 'collaborative' site with the participation of the Superintendence and research Institutes for the diagnosis, in order to obtain essential knowledge and comparisons for the elaboration of the most appropriate preservative and restoration choices. The contribution of the research Institutes, engaged in previous campaigns will be fundamental, as much as for the evaluation of the environmental conditions of the hypogeum as for the preservation state of the structures through the chemical characterization of the constituent materials, as well as the state of deterioration. The site restoration project is the result of the complicated surveys of the place between recognitions and analytical studies that during the work process will never cease to be incremented by comprehensive documentation aimed on what has and on what will be highlighted. The knowledge on the archaeological materials so far found, has given a great contribution on the research on the prime materials used on the sites and on the working techniques with the intent to discriminate the places and the production chronology, evaluating the origins. The diagnostics have been applied on most of the archaeological materials especially on the painted architectonic surfaces where we must comprehend the characteristics for preservation purposes. For the diagnostics on metallic materials (bronzes, iron), we have noticed the necessity for specific investigations to discover the origins, considering the extraordinary building planning with materials generally alien to this territory. The study activity has been extended to the skeletal remains of the crypts on the limited representative of about 1000 individuals of whom 600 adults and 400 sub-adults. There has been a anthropological and paleopathological research on the osteological human remains that have allowed us to find out numerous scientific data of extreme interest among them there are surgical incisions made in order to separate the cranium form the cervical spine that allow us to hypothesis past post mortem studies that were particularly interested in the back part of the encephalon. The acquired experience is fundamental regarding the preservation of the remains that have been achieved thanks to the interaction of factors especially thanks to the fundamental role of the automated system for the management of the installations, the structural and environmental control automations. The system for the monitoring of the micro climate, apart from recording

the microclimatic parameters, carries out the activation and deactivation function of the machines that guarantee the control in maintaining the best values to preserve the painting surfaces in the hypogeum environment.

Integrated Diagnostic Procedures on Yazılıkaya reliefs (Hattuša, Turkey)

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The rocky complex of Yazılıkaya represents one among the most famous and imposing monuments of the whole ancient Near East. The architectural program, probably conceived by one of the most significant dynasts of Hittite history, Hattusili III (second half of the XIII cent. B.C.E.) was effectively completed by his son Tuthalija. Yazılıkaya complex consists of a "labyrinth" emplaced among the discontinuities of a large limestone olistolith that emerges along a slope placed at around 3 kilometres north to the capital Hattuša (modern Boğazkale, Turkey). Already a worshipping place in ancient-Hittite times (XVI Century B.C.), it draws "scenery" celebrating the kingdom's pantheon. Two Chambers named A and B composed the monument, two divine series in relief carved in the stone were represented while proceeding along the longer wall sides of Chamber A; on the other hand, Chamber B represents a series of other sculptures, reporting primordial and chthonic divinities. Interestingly, all the reliefs are accompanied by the god's denomination in hieroglyphic script.

One of the most intriguing arguments that have ever stimulated the archaeologists regards the occurrence of painted decoration on the Yazılıkaya reliefs.

To this aim, in September 2018 researchers of Federico II, Sannio, Suor Orsola Benincasa Universities under the supervision of the Deutsches Archäologisches Institut carried out the first diagnostic campaign. The analytical approach included a set of in situ non-destructive/non-invasive techniques such as infrared reflectografy, ultraviolet fluorescence and reflectance imaging, Raman and external reflectance FT-IR spectroscopy with the main scope of finding traces of colour decorations on the stone surfaces of Yazilikaya reliefs. Some fragments of the decorated plasters from the Upper City Temple was primarily investigated unveiling the palette of pigments known to the ancient Hittites. The plasters showed a multilayer technology with two thin strata concluded with the painted decoration. Results of spectroscopic analyses and multispectral images provided a palette with 4 different pigments: ochre for red and yellow, Egyptian Blue for blue, and carbon for black pigments.

Unfortunately, the whole data set collected on the Yazilikaya stone reliefs did not give back satisfactory results on the presumed presence of colorants; this is mostly due to the intense alteration phenomena affecting these surfaces. As a matter of fact, Yazilikaya reliefs are presented as rough surfaces, however in some cases on limestone substrates a reddish-pink smoothed surface occurs (as in the case of King's statue n.64 and the warrior's procession n. 69-80). Microscopic observation unveiled that the smooth surface consisted of almost two thin layers overlying the limestone bedrock. Remarkably, the limestone substrate reported a regular path of stripes with different orientation where the two layers lack. Further analyses will be devoted to the interpretation of nature and purpose of these stripes. Spectroscopic analyses confirmed differences among the reddish-pink and whitish surfaces; the former is composed by oxalates along with traces of silicates and iron oxides whereas oxalates lack in the underlying whitish layer. On the other hand, the rough surfaces were generally affected by greyish to blackish patinas and lichens colonisations. As a matter of fact, UV images showed an intense fluorescence due to the diffuse biological activity. For a comprehensive view of the state of conservation, the mapping of weathering forms and damage was performed on three-dimensional models produced using different technologies for 3D digitisation. Biological colonisation, rounding, missing part and microkrarst resulted the most important weathering forms affecting the Yazilikaya reliefs causing a severe damage on whole monument.

Cognitive methodology and diagnostic plan for cultural heritage conservation

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The article proposes the results of a research aimed at supporting a work of conservation and enhancement of a monumental cult building of the Byzantine era, through a historical survey, an identification of the relevant characteristics of the building and a series of specialized laboratory investigations. The attention is turned to the abbey of Santa Maria del Pàtire, located in the municipality of Rossano, in Cosenza province (Italy); it is one of the most interesting Byzantine architectures in Calabria which, despite the continuous alterations carried out over the centuries, also due to damage suffered during some seismic events, is still today structurally compact and intact. The monumental complex has in any case been the focus, over time, of restoration measures and partial transformation actions. The ruins of a cloister and the church built together with the convent.

Figure The apses of the church of Santa Maria del Pàtire,

The heart of the research is the characterization of the Church constitutive materials for conservative purposes, in a cultural perspective of prevention of potential degradation forms. To this end, a diagnostic plan was developed, articulated in coordinated phases that include both the cognitive analysis of the environmental and settlement context and the cognitive analysis of the artifact through a specific anamnesis and a photographic dossier. In particular, in this paper the results of the in-depth analyses related to the petrographic analysis are presented on some representative samples of building structure materials aimed at detecting any forms and extensions of soil degradation. The degradations are tributaries of the various contaminations suffered over time, mainly by water and air; in the absence of adequate prevention works or safeguard treatments, degradation tends to expand, aggravating the contaminated state of the building. The meaning of a methodological approach in the preventive analyses is therefore emphasized that, in order to be effective, carefully and expert techniques must be used, and may be useful for guiding the most suitable method of intervention or suggesting solutions for effective conservative intervention.

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Diagnostic tools to preserve and enhance an archaeological site making it accessible to visitors: the case of Marino Mithraeum (Rome)

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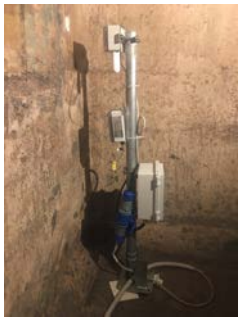
Conservation of hypogea and their accessibility by the visitors is a hard question, due to the interaction of different factors as the intrinsic characteristics of the hypogeal environments and the presence of tourists. Studies on underground sites have identified the main causes of the mechanisms of degradation - both chemical (crystallization of salts [1]) and biological (formation of microorganisms and algae [2]), - in the thermo-hygrometric exchange processes. In these environments, the temperature is relatively constant and the high humidity rate (over 95%) can promote the growth of micro-organisms; moreover, the presence of visitors could represent a further risk compromising the integrity of the environment equilibrium [3-4]. This equilibrium (temperature, humidity, CO_2) could be further changed by the required scene set-up for public opening (such as artificial lightning, power grid, etc.). In this context, a fruitful relationship between experts in the field of cultural heritage and the managers of the site it is fundamental to ensure the protection of heritage for future generations.
In this paper the main results of the preliminary diagnostic campaign on the wall painting of *Mithras and the Bull*, and the microclimatic monitoring carried out since June 2018 inside the Mithraeum of Marino Laziale (Rome) are discussed. As a result of this study, it's possible to define strategies of fruition of this suggestive archaeological site - not accessible to visitors yet - in compatibility with its exigency of conservation.



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The restoration of the St. Michael Archangel of Reggio Calabria: the contribution of technical analysis to its attribution.

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The panel painting *"San Michele Arcangelo killing the dragon"* by the Fondazione Piccolo Museo San Paolo in Reggio Calabria is celebrated as "the most significant evidence of the figurative culture of this region in the first half of the fifteenth century"[1]. The lack of a critical study able to reveal its provenance gave further cause for its hypothetical attribution to Antonello da Messina advanced in 1993 by Msgr. Francesco Gangemi[2], later studied and evaluated during the ISCR diploma thesis of the author[3]. The research and the ongoing conservation activities gave the opportunity to deepen the knowledge of this panel through the analysis of all its technical and scientific aspects, proving their importance in the discussion regarding its attribution.

Thus demonstrating how much the understanding of the technique of execution and the scientific analysis of the materials can contribute to the historical study of an artwork. In relation to the attribution thesis, the analysis on how the support was originally executed played an important role in the research because it helped in the definition of the artwork itself. A lot of details on the painting materials and techniques that couldn't be detected by naked eye were revealed through X-ray examination.

In addition, other kinds of analysis were undertaken, such as: chemical investigations to identify the binder, optical microscopy of two stratigraphic sections of samples taken from the painting, the scientific investigation in order to define the organic elements (wood species and vegetable fiber) used for the *incamottatura*[4].

All the additional scientific investigations are conducted in collaboration with the ISCR of Rome: Infrared Reflectography to trace the presence of the preparatory drawing, false-color infrared, UV fluorescence, X-Ray fluorescence, for the study of the color palette. The ongoing restoration is also planning the aspects related to the aesthetic presentation of the painting, due its fragmentary condition, proposing also the use of virtual reconstructions.

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A sustainable strategy for microclimate characterization of museum environments for the preservation of traditional oil paintings

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([a])

This conference will present a short re-examination of the various aspects related to both the conservation of traditional oil paints and to the environmental control in museums.
The first aspect to consider when assessing the state of conservation of traditional paintings is an analysis of the mechanical and chemical response of their composing materials to microclimatic factors such as humidity, temperature, light and air pollution.
Concerning these factors the normative had developed strategies for microclimate assessment, but these approaches are very general and often developed to be applied in modern museums designed *ex profeso*. When considering the set points of micro environmental control, established by the current normative, they are often too narrow and unreachable on historical buildings, where tight control of factors such as temperature, humidity and air circulation are impossible. Even more these narrow limits of control, had been pointed out as being not sustainable in the long term, by recent works.
Thus, this conference will focus in the presentation of a sustainable strategy that can be adapted to the monitoring of the microclimate of historical buildings that preserve oleo paints collections.

Portable Nuclear Magnetic Resonance: cultural heritage applications

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Portable Nuclear Magnetic Resonance (NMR) devices offer different techniques for investigating the pore space structure and its interaction with hydrogenated fluids for a wide class of porous media. Porous rocks[1-3], frescos, woods and canvas [4] are part of the materials investigated. Structure, fluid-flow properties, water absorption, water diffusion and exchange among compartments are typical phenomena examined.
This work depicts NMR single-sided applications to materials of interest to Cultural Heritage in which techniques, data-acquisition methods and data-analysis algorithms [5] can be applied to get unique information.
Compact and mobile single-sided ^{1}H NMR sensors, as the NMR-MOUSE (Magritek, Germany), can perform NMR profiles to assess the performance of conservative compounds applied to limestone [3], as the penetration depth and the distribution of the product inside the unconsolidated substrate, Figure 1. The connectivity of the porous matrix of the stone after the treatment can be evaluated [2] by a 2D NMR exchange-relaxation experiment. The study of the transverse relaxation times and of the diffusivity properties of moisture in the porous material allows one to non-destructively characterize the average pore size of the stone to estimate changes after the application of the treatment.
This work demonstrates that non-invasive and non-ionizing NMR techniques, performed by portable devices, are a powerful tool for evaluating properties and characteristics of porous materials. Portable NMR devices, and NMR techniques in general, offer useful approaches to monitor procedures for the restoration and the conservation of artefacts of interest to Cultural Heritage.

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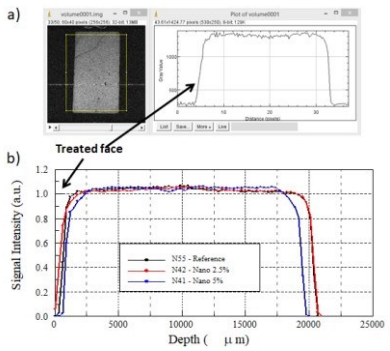

Figure1: Maastricht stone sample treated with the nano-silica compound applied in solution after fully water-saturation.
Comparison MRI and MOUSE Profile. a) MRI of an internal slice by a Varian 1.5 T tomograph and a profile reconstruction from MRI. (b) Proton density profile by NMR single-sided instrument MOUSE PM25.

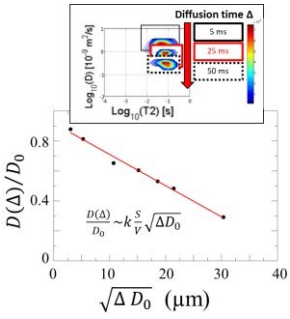

Figure2: Two-dimensional diffusion-relaxation experiment for a fully saturated Lecce stone. D-T2 map was obtained by 2D-Inverse Laplace transformation. Attenuation of the apparent diffusion coefficient D(Δ) as a function of the diffusion length. MOUSE PM10.

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Climate and Cultural Heritage: the case study of "Real Sito di Carditello"

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The following work presents the results of a monitoring campaign performed on the Real Site of Carditello (San Tammaro – Caserta - Italy).
In detail, parameters related to air quality were evaluated, in order to control and prevent the risk of degradation of Cultural Heritage. At the same time, by using field equipment, non-invasive and non-destructive investigations were carried out to: (i) identify constituent, restoration and/or degradation materials belonging to the wall paintings on the main floor; (ii) assess their conservation state under the current environmental conditions detected during the monitoring phase.
The realization of the monumental complex of the Real site of Carditello started in 1787, when Ferdinando IV di Borbone entrusted the construction to Francesco Collecini (1724-1804), a pupil and collaborator of Luigi Vanvitelli. The decoration of the central building of the complex was instead directed by the German painter Jacob Philipp Hackert (1737-1807).
The analysis activities were carried out in the context of the project "Innovative methods and technologies for the conservation, valorisation and use of cultural heritage: environmental and archaeological analyses", within the CULTURA CREA program (MIBACT), which aims to provide innovative services for the knowledge, conservation and enhancement of cultural heritage, through environmental and archaeometric analyses.
Environmental monitoring was performed both outdoor (to assess the effects of atmospheric pollution and changes in the climate of the structure) and indoor the rooms of the site (to evaluate the conditions of conservation and fruition of the artworks).
In particular, the following parameters have been monitored:

- Temperature, Humidity, NO_2, SO_2, Brightness (indoor room).
- Temperature, Humidity, NO_2, SO_2, O_3, PM, Rainfall, Anemometry, Visible and Ultraviolet Radiation (outdoor).

The collected data are reported in a web platform, where one can check the real time monitoring data. The platform integrates both environmental data and information regarding the "health status" of the site, in order to have a diversified and detailed analysis of the Cultural Heritage, useful for its protection. The results obtained from the monitoring campaign provide parameter values within the regulatory thresholds, even if the area in which the historical site is located has undergone significant anthropic impacts over time .
The in-situ investigations (IR thermography, infrared reflectography, UV fluorescence, X-ray fluorescence) have been aimed to identify the pigments, the execution technique and to evaluate previous degradations or alteration persistent causes. Chemical markers allowed to date in an indirectly way the restoration works carried out during the nineteenth and twentieth centuries as a result of damage suffered during insurrections and war events. The imaging techniques have localized the retouching or remake and detachments areas on the analyzed painted surfaces, providing a useful support for future consolidation operations. All information has been acquired by the guides who, during the visits, illustrate to visitors the scientific results to confirm the historical retrace of the wall paintings.

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"Invisible Archaeology": a new Museo Egizio exhibition about archaeometry and biography of objects

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A new Museo Egizio exhibition, titled "Invisible Archaeology", will open in March 2019.
The scientific project is centered around the growing relationship between Egyptology and sciences (such as Chemistry, Physics, Radiology), and how these are employed in the study of the artifacts of the Torino-based collection. These analysis produce information that would otherwise be inaccessible and invisible to the naked eye and that allow the researchers to fill the gaps on what is unknown about the history/biography of the objects (who made them, why, when, where, with what materials, where was it found) and to define the best ways to preserve them.
The exhibition presents visitors with an interpretation of the ancient relics that, through the investigation of the materials, favours sense perception and rational thought, providing a more authentic experience of the finds themselves.
Scientific method and investigation are proposed not just as the only possible instruments for deciphering the experiences embodied in the objects, but also as a new *language* to emancipate visitors from that patinated and stereotyped representation of the culture and history of ancient Egypt which traditionally reduces its depth and richness to a gallery of clichés.

The return of *Uomini illustri* to Urbino: from scientific investigations to real and virtual exhibition

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"Lo Studiolo del Duca. Il ritorno degli Uomini illustri alla Corte di Urbino" is the title of the exhibition organized in 2015 at Palazzo Ducale of Urbino by Marche BSAE Superintendence with the participation of Louvre Museum. The exhibition and the catalog (Marchi 2015) were a unique opportunity to present the 28 portraits of Uomini Illustri to the public gathered together for the first time in the Studiolo del Duca after the seventeenth-century division. Therefore only half of the portraits are located inside the Galleria Nazionale delle Marche; the remaining 14 paintings, which arrived at the Louvre Museum in 1863, never returned to Italy, except on the occasion of this event.

The exhibition was also an excellent opportunity to illustrate the results of the project "*Diagnostic investigation on the Famous Men of the Studiolo del Duca*", started in 2008 from a close collaboration between Marche BSAE Superintendence, the University of Urbino (DISPeA), the University of Bologna (M2ADL and DIFA) and Louvre Museum (C2RMF). The research project aimed at providing a tool for the scientific knowledge of the 28 portraits and at obtaining useful data to solve the complex issue of attribution. The portraits have been subjected to both non-invasive and micro-invasive investigations. The results obtained from the research (Menu et al, 2011; Mazzeo et al., 2009) have allowed a deeper understanding of the executive technique of the palette used for the realization of the portraits and the identification of common elements with the painting of Just of Ghent. It was also possible to identify some substantial changes that were made both in the drawing and at the pictorial level.

The itinerary of the exhibition began with an introductory video projected in high definition on a large 6-meters self-supporting wall that showed, in short, the history of the Palazzo Ducale and the Studiolo; the projection, accompanied by engaging music, was subtitled by captions in both Italian and English languages. Before entering into the Studiolo del Duca, two large 50-inch multi-touch tables in FullHD double-sided with infrared technology allowed the visitors to navigate throughout the 28 portraits, enlarging every single painting in high definition and analyzing it through an iconographic-descriptive card. While leaving the Studiolo, two other large multi-touch desks allowed the visitors to visualize the analytical results deriving from the aforementioned diagnostic project. The user of the desk (with the help of a scientific glossary) is allowed to choose the topics of greatest interest: the wooden support, the preparatory and pictorial layers, and the underlying design. The exhibition path ended with a large 4-meters screen through which the visitor may view every single painting, through the superposition of the different multispectral images made during the diagnostic campaign. The exhibition is an example of how digital imaging technologies can ensure a more intense involvement of the user, ensuring wide access to the cultural heritage and their historical, artistic and scientific contents. For this purpose, DNA Cultura, using Oculus Rift, through which visitors can immerse themselves in the completely virtual reality of the Studiolo del Duca, has recently designed a completely interactive experience. This on-going project may allow the tourists touring Louvre Museum to benefit of a 360° view, the 28 Uomini Illustri in full scale, just as if they were visiting the Palazzo Ducale in Urbino.

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"MOBARTECH": a mobile, interactive and participatory platform for the study, conservation and promotion of Cultural Heritage

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The MOBARTECH project, funded by Regione Lombardia, proposes the development and the test of a technological platform. It integrates cultural, social and creative skills and abilities with enabling technologies (such as Information Technology, non-invasive scientific analyses, devices and methods for image acquisition and processing, technologies and methods for conservation and restoration, intelligent logistics systems, public interaction and infotainment technologies (information + entertainment), for the provision of high added value services applied to historical-artistic assets.
The project leader is Arterìa, a modern and innovative company that offers logistics dedicated to fine arts and valuable items. Besides, two companies participate: XGLab, whose core-business is the development of high-performance electronics and instrumentation for X-ray and Gamma-ray applications and Space, a company of technological innovation dedicated to enhancing and communicating cultural heritage. Three Universities (Università degli studi di Milano-Bicocca, Università degli Studi di Milano and Università Cattolica del Sacro Cuore), a public research institution (CNR-IBFM) and a private non-profit foundation (Eucentre) are involved.

The MOBARTECH platform is based on a centre of "soft and hard" skills and technologies dedicated to the creation of services applied to the Cultural Heritage field. It consists of a) a centre of cultural and social competences, b) three technological laboratories (Laboratory of Diagnostic Analysis, Laboratory of Conservation and Restoration, Laboratory of Image Processing, Public Interaction and Communication), distributed in the Milan and Pavia areas, and c) a "mobile" laboratory that allows the in situ analyses and that acts as an "open lab" for the public.

The general objective of the platform is to support, in an innovative way, the study, conservation, education and access of Cultural Heritage to the public, encouraging the development of new creative processes that can enhance the approach to historical assets.
Moreover, the possibility of using a mobile vehicle that can simultaneously act as a technical laboratory and open-lab, ensures the removal of some barriers to knowledge, such as the difficulty for the public to physically reach the Cultural Heritage or to understand the study and conservation actions that maintain or increase the value of the asset.

An innovative experience of dissemination: MAGNA project, on the route from Greece to Magna Graecia

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Ancient Greece is considered the cradle of Western civilization, in terms of culture, scientific, technological and philosophic knowledge. These latter ones spread in the colonies of Magna Graecia in Mediterranean Basin leaving today important archaeological traces to make usable to the community. In this regard the project financed by EASME (The Executive Agency for Small and Medium-sized Enterprises set-up by the European Commission) "MAGNA, On the route from Greece to Magna Graecia" means to develop a transnational thematic touristic route between Greece and the Ionian coast of Calabria an ancient Magna Graecia colony on the basis of cultural and historical connections between these two Mediterranean areas. The project aims to promote the touristic development of the Greek and Calabrian archaeological sites through activities of dissemination about scientific subjects regarding the conservation of Cultural Heritage both in subaerial and underwater environment, the study of the sea floor and the pollution by microplastics of the sea water.

The routes on the Greek coast will involve Corfu, Lefkada, the ancient Oiniades, Zakynthos, Katakolo, Olympia, Corinth. The Italian sites are located on the Southern Calabrian Tirrenyan and Ionian coasts: the Museum of Reggio Calabria, Locri Epizephyri (RC), Kaulon (RC), the underwater shipwreck of Punta Scifo (Crotone), Capo Colonna (Crotone), The Aragonese Castle of Isola Capo Rizzuto (Crotone).

The touristic products realized in the project consist of cruises on a ship equipped with scientific instruments in order to offer unique cultural experiences accompanied by multimedia supports (illustrative videos, editing blogs, Social Networks, Web sites).

People will be able to choose different activities to do during their holidays on board, on sea and on land. The on board activities consist of exploration of the seabed with sonar and ROV; knowledge of the marine environment and the pollution throughout the direct experience of microplastics sampling; laboratory of ceramics where both adults and children will become real archaeologists and conservation scientists studying and classifying pottery artifacts dated back to Magna Graecia period. The on sea activities include diving, surfing, fishing and kite-surfing. Moreover tourists will be able to visit places of interest on the coasts such as the archaeological sites, the modern cities, the main attractions provided by the rounding areas. Finally the holiday packages offer food and wine tours to discover the ancient dishes of Magna Graecia and the rich traditional cousine of Calabrian and Greek coasts.

Acknowledgements

The project Magna, on the Route from Greece to Magna Graecia is funded by the Executive Agency for Small and Medium-sized Enterprises (EASME) set-up by the European Commission in the program European Maritime and Fisheries Fund (EMFF)

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Excavation of the Eastern Gate of Skotoussa, Thessaly (GR): Archaeological illustration and 3D rendering via laser scanner.

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The site of Skotoussa, located in Thessaly, occupies a hilly area between the plain of Pharsalus and that of Pherae-Larissa, west of Mount Halkodonio. Archaeological surveys have been conducted on site thanks to a collaboration between the Department of Ancient and Modern Civilizations of the University of Messina and the Ephorate of Antiquities of Larissa, which have been cooperating on the ground since 2014.

During the first year of activity, a systematic project was launched in order to acquire a more detailed knowledge of the fortifications' pattern, with the double goal of understanding their technical and topographical characteristics and defining the limits of the urban area.

In total, we identified 41 segments e 24 quadrangular towers (about 6 x 6 m) and hypothesized the presence of some of the access gates to the city.

With the 2015 campaign, we started an extensive excavation of the Eastern sector of the fortifications (about 42 x 15 m), which includes within itself the two defensive towers B and C.

The area, which can be identified as one of the entrances to the city, provided us with proof of a long occupation, although with numerous intervals, covering a chronological period that spans from the IV century BC to the XIII century AD.

During the last survey campaign, we decided to integrate the graphic documentation of the excavation with laser scans obtained by using the equipment made available to us by the IPCF-CNR Institute of Messina. The instrument we used is a terrestrial laser scanner, model FARO CAM2 Focus3D S 120, with a visual field of 305° (vertically), 360° (horizontally) and a margin of error of ± 2 mm. We obtained photorealistic 3D colored scans, with a 70MP resolution and colors overlapping without parallax.

Because of the longitudinal development of the fortifications, we had to capture 20 scans focused along the entire readable portion of the walls, with a greater concentration in the area corresponding to the wall gate for a better documentation of the structural collapses identified during the 2015 excavation campaigns.

The scans were processed through the combined use of specialized software like FARO SCENE and Gexcel's JRC Reconstructor. After point clouds were produced, a textured triangle mesh was generated.

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Integrated survey methodologies for documentation and reconstruction of historical buildings: the Castel of Scalea (CS, Italy)

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In the last years the 3D documentation and the has become an indispensable tool for specialists in the field of cultural heritage, both for archaeological analysis, reconstruction and interpretation, and for promotion of monumental and archaeological artefacts sometimes inaccessible or in a bad state of conservation.
The disciplines of the modern Geomatics offer many opportunities and solutions for integrated digital surveys (ground-based survey methods and image-based UAV photogrammetry).
In this paper, will be presented the research results and documentation methods applied to the study of the Castel of Scalea (CS, Italy). The site is part of a complex defensive network built in the Middle Ages along the Tyrrhenian coast of northern Calabria. Although the first installation has been designed during the Norman period, the structures were subjected to various reconstructions during the following centuries, up to the eighteenth century, while maintaining its original strategic and defensive function.
The analysis of the geo-morphological articulation of the site and the different wall buildings techniques allowed the recognition and the dating of the all the chronological phases of occupation.
In this operation the deployment of aerial close-range aero-photogrammetry (the instrument used for acquisition is a DJI™ Phantom 4 with integrated GPS), in association with traditional ground-based methods (total station and D-GPS positioning technologies) proved to be essential to get in short time multiple results: a high resolution photographic coverage of the whole site (to be used for monitoring); a 3D and 2D georeferenced and orthorectified base-map of the site to be used as a tool for plano-altimetric definition of the hill and visible structures; oriented and detailed GEOtiff images (useful for updating the CAD plan of the structures); a base for creating ortho-digital drawing of wall prospects (useful in digital restoration, stratigraphic readings etc); a detailed 3d model (dense cloud and TIN) for metric measurements and for the realization of multimedia products (education and virtual visit).
These methodologies allowed to obtain not only the basic support for interpretation analysis, but also a model of the actual state of conservation of the site on which some reconstructive hypotheses can be based on; moreover, the use of UAV has been useful to integrate the documentation of some features located in inaccessible positions because of the morphological articulation of the site.

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Use of RTI light interpolation for profilometry and 3D rendering of Cultural Heritage objects

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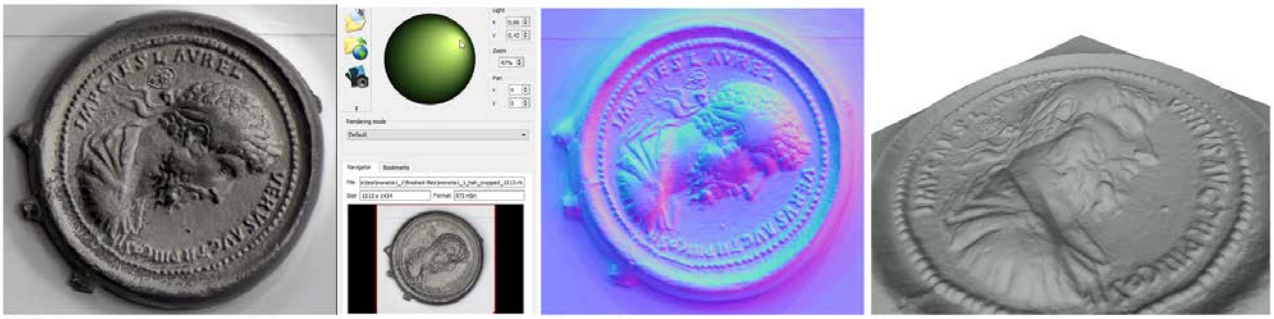
Reflectance Transformation Imaging is an imaging technique for visualising a surface under a spatially variable source of illumination. A set of images of the object of interest is captured by keeping the camera position fixed and changing only the direction of the light source, which may be different depending on the case.
By means of a reflective reference sphere, the value of the incident light direction can be obtained for each image. The luminance dependence on the light direction provides information on the surface of the object obtaining a false colour image that represent the map of the object's normals where each RGB pixel value represents a vector normal to the surface. Through the integration of the normal map, it is possible to reconstruct the heights map coinciding with the object's profile.
Currently, to represent the profile of an object surface, high-resolution profilometers are the best methods. With this work, we propose an alternative and innovative technique, which is also non-invasive since it is not necessary to touch or move the object.
The aim of this work was addressed in analysing different test samples and real objects, to compare the dependence of the reconstructed object profile on the acquisition techniques, the computational algorithm and on the specific geometry of the sample.
The quantitative results show how the various techniques related to different object could affect the final RTI image and how the choice of the type of algorithm can best represent the profile with the higher spatial resolution.
The reconstructions of profiles aim to represent the object in the closest way to the original and eventually enhance its characteristics allowing, for instance, a better readability. Furthermore, profile models enables scholars to study those objects under a new light, but also open to a wide audience the possibility to interact with rare artworks.



RTI interactive re-lighting view | Normal map | 3D reconstruction

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Virtual archaeology between disclosure and scientific research. The role of an expert in private companies.

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In recent years there has been an ever increasing demand of skilled multifaceted professionals with the ability to translate the mute archaeological artefact, alone incapable of communicating with the general public, into visual and virtual objects. The profile requested is that of an actual intermediary that renders the dialogue, more often than not rather difficult and equivocal, between different actors (such as the scientific community, clients, developers and end-users) linear and clear.
If we take a look at virtual or augmented reality we'll soon find ourselves confronted with a field in great expansion where this specific expert has yet to be precisely outlined, but is doubtlessly necessary. What skills are in demand? Who can recreate such a particular reality? Certainly, neither a traditional archaeologist nor a graphic designer lacking scientific understanding would be able to independently move forward. An expert technician with scientific knowledge, interpretative and practical skills is essential, a professional that will find in this virtual reality the perfect opportunity to gain valuable training and professional growth.
The Digital Archaeologist has finally debuted, a qualified expert that not only detects reality as is, but that also processes and integrates the missing data acquired in the digital world to ultimately offer a new, different reality. Obviously the input of multiple professionals is needed when dealing with a wider, more complex project, but the Digital Archaeologist takes on the role of mediator amongst the parties involved. In many cases, in fact, whether the client is a museum or a private customer, the ultimate goal is to inform the public, on different levels, about the wide range of mediated and structured content guaranteeing that all is fully understood and appreciated. It often occurs that contents refer to a reality that no longer exists and, consequently, built on a variable interpretative gap. The latter is precisely one of the many points considered in the following pages: how does one communicate the percentage of reliability of the data and how much of what was reconstructed is factual or interpreted?
Today we can go to archaeological park or to a museum and, with the simple use of a digital device, admire a hypothetical ancient reconstruction of the object observed. There are many possible project ideas [1] and infinite are the potential outcomes [2], but we must bear in mind that this is a new and evolving world. In this paper we'll discuss specific cases whilst analyzing in detail both the solutions and the compromises that the Digital Archaeologist must make to develop a model or a digital artefact and what exactly he or she wants to communicate with it.

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Revealing Mithras' color with the ICVBCMobile lab in the Museum

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The National Museum of Rome (9th room of the *Terme di Diocleziano*) has an important collection of Mithraic sculptures found in the years 1973-75 during the archaeological excavation under the early Christian basilica of Santo Stefano Rotondo on the Caelian hill. The church was built in the 5th cent. on the area formerly occupied by the barrack of the *Castra Peregrina*, which hosted one of the better preserved Mithras cult places. The sculptures from this Mithraeum show many traces of gilding and polychromy, whose best example is the great relief with Mithras slaying the bull exhibited in the museum. The slab, of the late 3rd cent., was compared with other marble sculptures coming from the same place or generally related with mystery cults in Rome. The analysis were conducted during a three days campaign in the Museum with portable instrumentation of the ICVBC mobile laboratory following a completely non-invasive approach.
This work is part of a more general research line exploited in the last years for studying the traces of polychromy on Roman and Etruscan sculptures [1-4].

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X-ray Computed Tomography *in situ*: an opportunity for Museums and Restoration laboratories

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X-ray CT is one of the most complex and sophisticated non-destructive imaging techniques, capable of providing a 3D reconstruction of the object analyzed and to answer many questions about the manufacture, function and conservation status of heritage objects.
Most of the CT studies in this field have been conducted using medical scanners, but these instruments are optimized for the human body and their application to Cultural Heritage assets is characterized by strong constraints with regard to the maximum size, shape, and density of the object to be analyzed.
In order to overcome these limitations at the *X-ray Imaging Lab* we designed and developed several customized CT systems, expressly conceived for analyses in the Cultural Heritage field. The designed instruments are able to perform analysis *in situ* on most of the materials including ceramics, metal objects, and organic items, such as wood, paper and human remains.
In particular, we will present two of our systems and the results of some important tomographic campaigns performed inside museums and restoration laboratories.
The first system - designed for medium-size objects (up to 50 cm) - is equipped with a microfocus X-ray tube (max voltage: 130 kV) and a flat-panel detector with an active area of 19.5 × 24.2 cm^2. This system is suitable for the analysis of objects made of not too high density materials with a resolution of few tens of microns.
The second tomographic system - designed for large-size objects (up to 200 cm) – is equipped with a powerful X-ray tube (up to 200 kV and 750 W) and a fast flat panel detector with 1216 × 1232 active pixels with 100 μm pixel size. This system is suitable for the analysis of more absorbing objects and, thanks to the automatic acquisition process, requires only 3 minutes for each tomographic acquisition with a typical resolution between 200 μm and 1 mm.

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Mobile laboratories for restoration and diagnosis projects in museum sites.

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Diagnostic analysis and restoration work have been growing in appeal with the public and performing them in front of visitors is an innovative way to utilize museums and heritage sites. However, this work needs a suitable environment in order to be done in an effective, correct and safe way. For more than three decades, the Istituto Europeo del Restauro has been working on this, putting together a series of mobile laboratories aimed at operating in museum spaces where they are carrying out important projects. Since the beginning of the 90s, the Institute has conducted numerous restoration projects in public, and in 2014 the Musèes Royaux d'Art et d'Histoire in Brussels chose I.E.R.as its partner for restoration and research on one of its most precious treasures, the collection of Egyptian sarcophagi from the XXI Dynasty, which was rediscovered in the second cache of Deir el-Bahari. After the initial diagnostic phase on Ischia[1] at the headquarters of I.E.R., the public restoration project became an integral part of the grand exposition "*Sarcophages. Sous les étoiles de Nout*" curated by the Musées Royaux d'Art et Histoire. In the MRAH rooms, the Institute set up for the first time "Europa. Expositive Laboratory Module", a true modular laboratory equipped with the most advanced technology both for the restoration work and for the use of visitors. Here, the Institute team spent six months working live, prompting involvement from the audience, which helped "Europa" win the Visit Brussels Award 2015-2016 in the New Concept category and earn the Medal of the President of the Italian Republic for the event. The Europa project continued in 2017-18 in Syracuse at the exhibition "*La Porta dei Sacerdoti. I sarcofagi egizi di Deir el Bahari esposizione e restauro in pubblico.*" There, "Europa 2.0" (continuing development of the first model) performed the delicate work of DNA sampling, in addition to restoration and diagnostic analysis, in collaboration with the Center for Research on Ancient Biodiversity and DNA at the Università del Sacro Cuore. With the analysis of these I.E.R. experiences at the end of 2017, two projects done in collaboration with the Favaretti Group and aimed at creating two particular models were launched – "REMM Restoration Expositive Mobile Module" and the Diagnostic room. The goal is to provide workers in this sector with efficient tools and to involve the public in the process, thus transforming two highly specialized procedures – restoration and diagnostics – into a unique and memorable event with an important cultural impact.

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Europa. Expositive Laboratory Module

ARCA 2.0: a Web-based framework for Automatic Munsell Color Characterization for Archaeology

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ARCA 2.0 (Automatic Recognition of Color for Archaeology) is a web-application for estimating Munsell Colors (Fig.1). Images are given as input to the framework, which allows color-picking to extrapolate RGB values to be converted into Munsell ones. The Munsell system is useful to record or communicate to other scholars the surface color of specimens. In archaeology, Munsell Soil-Color Charts are used to identify the color through direct visual comparison in the excavation sites. The comparison by visual mean employing Munsell Soil-Color Charts is subject to the issue of different color perception by different subjects. ARCA2.0 is designed to solve this problem, collecting objective estimates of the colors. The estimation is implemented through conversion coefficients obtained through a regression algorithm similar to the one proposed by Gomez [1], that consists in the construction of 9 models of polynomial equations of the form Y = f(X), where X is the input of the equation, corresponding to the sampled RGB values, f is the polynomial function corresponding to the selected model, and Y the expected output (in our case, HVC or L* a* b* triplets). The Munsell Soil-Color Charts were acquired using 3 devices (2 smartphones and a REFLEX camera). Currently, the regression model is trained with the images acquired with the first smartphone (Huawei P10 Lite), while the other devices are used for evaluation and validation of ARCA. Perceived color is influenced by several factors, i.e., the Human Vision System, lightning conditions, and quality of the acquiring device. In our experiments, we measured how much the regression models fitted the Munsell Color Space. Then, we processed the images in our dataset in order to obtain the color device-invariance. Our outcomes show that balancing with a reference white, followed by an equalization step [2], provide the best method to gain the color deviceinvariance. This device invariance procedure is used in ARCA 2.0 to improve the regression model augmenting its resilience to the different possible acquiring devices.

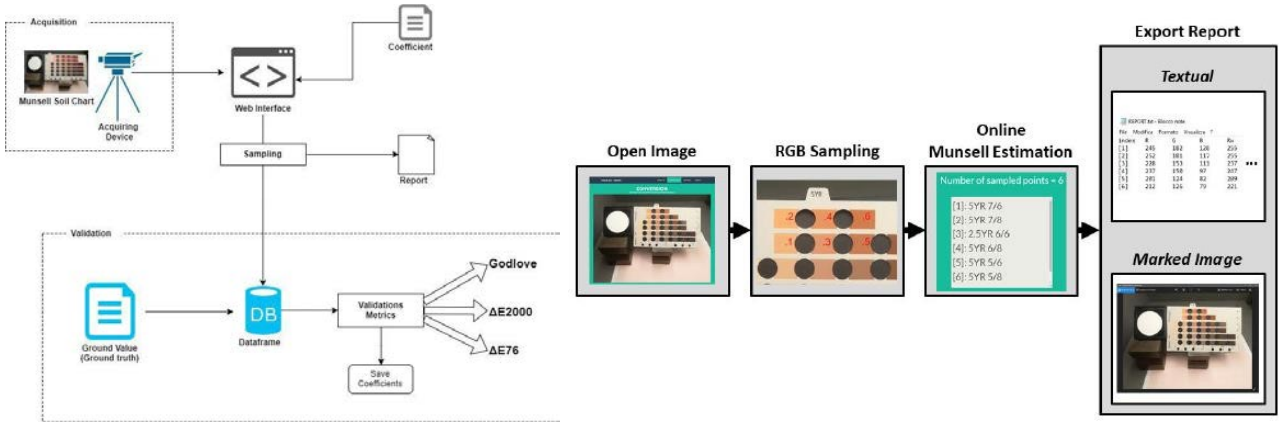

Fig.1 – Regression pipeline (on the left), and ARCA2.0 website workflow (on the right).

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The access to MOLAB advanced mobile analytical instrumentations: new opportunities for European researchers in Cultural Heritage

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Founded in 2001 at Perugia University in collaboration with the Institute of Molecular Science and Technology of CNR, MOLAB has been conceived as a mobile facility which allows scientists, conservators, art historians and archaeologists to carry out non-invasive scientific studies on cultural heritage objects. Since 2004, MOLAB has been the first (and unique) mobile transnational access supported by the European Commission through the Eu-ARTECH (FP6) and CHARISMA (FP7) project. Presently, it is one of the three platforms offering transnational access to European users within the H2020 IPERIONCH project (www.iperionch.eu) and national access to Italian users within the E-RIHS.it project (www.erihs.it). MOLAB is composed of a unique set of optical/spectroscopic techniques all sharing two essential features: the portability and the non-contact running mode for in situ and non invasive investigation of art-works, respectively. The MOLAB approach is based on the combination of both imaging and point analytical techniques exploring the wide electromagnetic spectrum, ranging from X-ray to the IR region. Within the last decade of activity, the approach offered by MOLAB enabled an in deep investigation of a wide range of cultural heritage objects in the full respect of their integrity and value.

^{14}C dating and contemporary art: the case study of Concrete Art

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Dating contemporary art by radiocarbon can be useful thanks to the so-called Bomb Peak, which can give us a high timing resolution for the period starting 1955.
However, the materials used by artists of this period can be very different from the "traditional" ones; they are often very complex and may vary both in composition and provenance. Moreover, they may be mixed with synthetic resins and glues, that are difficult to remove with the usual sample pre-treatments, thus making data interpretation not so straightforward and even measurements useless.
In this study, we collected six samples from the supports of different artworks belonging to Concrete Art, an artistic movement developed during the middle 20th century, mainly in Brazil and Argentina, based on abstract and geometric forms. Typical used materials were various e.g. plywood, hardboard and cardboard, derived from wood processing, either with or without any adhesive, but also new matters, such as cellotex.
In order to apply an efficient treatment to remove the possible contaminations, μATR-imaging spectroscopy was used as diagnostic tool to characterise samples surface. Unfortunately, as we expected, this technique gave us only qualitative information since it cannot discriminate between components derived from possible contaminations and from the original matrix (for instance, the functional group C=O is present both in wood structure and in synthetic resins).
As a first approach, ABA pre-treatment was applied and radiocarbon concentrations were measured by Accelerator Mass Spectrometry (AMS). Two of the measured samples (cellotex and one of the plywood fragments) resulted to be contaminated by old carbon, as the removal of synthetic substances was not complete. The others samples gave results which can be compatible with what expected even though, in case of post-1955 results, the association of the obtained data to the actual date is not unambiguous.

The mystery of "Tremiti plates wreck": insight on the nature of metal plates

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The Tremiti island seabed is full of archaeological sites, one of these is constituted by a cargo of hundreds of metal plates not well historically collocated.
In this work the study of some metal plates is reported, with the aim to provide new indication for the archaeologists.
The first preliminary information was obtained by using the X-Ray Fluorescence (XRF) spectroscopy. This technique revealed the composition of the sample, an alloy constituted by copper (80% w/w), lead (15% w/w) and low amounts of antimony, arsenic and silver. The amount of lead is very surprising if compared with others historical copper alloys.
On the basis of the above results, we decided to perform more deepen XRF analysis, Neutron Resonance Capture Analysis (NRCA) and Neutron Diffraction (ND) experiments.
The XRF analysis was performed in several points of two plates. Neutron experiments were performed on INES line at the Rutherford Appleton Laboratories (ISIS). The NRCA elemental technique gave complementary information of XRF revealing the composition of the bulk. The neutron diffraction allowed to determine the phases composition mainly alfa copper and bronze phases and lead phase, revealing information about the production technology [1].
In order to get more insight about the elements distribution and the microstructure, a metallographic investigation was performed on a cross section that was analysed by Optical and Scanning Electron Microscopies (OM and SEM).
The combined use of these techniques give a synergic information for the metal description. Results of the investigation will be provided in the poster.

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Il *kouros* ritrovato. Preliminary studies for reassembling the two anatomical parts of the sculpture in Parian marble from Leontinoi

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The "Apollonian head" found by Ignazio Paternò Castello, Prince of Biscari, in the eighteenth century and now at the Ursino Castle Museum in Catania, and the torso of acephalous ephebus acquired by Paolo Orsi in 1904 and now kept at the Regional Archaeological Museum in Syracuse that bears his name, have been the subject of an archaeometric study aimed at solving the dispute that for years has engaged the scientific community in conjectures and hypotheses on whether the two finds belong to a same statue of the Archaic period: the *Leontinoi Kouros*. The results of petrographic and isotopic analyses showing that both pieces were obtained from the same block of marble (from one of the open-pit quarries of Lakkoi, on the Greek island of Paros) and from a study of the surface anatomy have proven beyond doubt that the two finds belong to the same statue.
The image of the *Kouros* was obtained by creating a three-dimensional model using a laser scan with submillimetric resolution. This effort made it possible to faithfully reproduce the contact surfaces between the two parts of the sculpture and to create, using rapid prototyping techniques, a diaphragm in high-strength plastic material to fill the very small gap made when the base of the head was smoothed in the eighteenth century to place it on a pedestal. This allowed restoring the neck's continuity by reassembling the two parts with reversible systems that have made the two finds a single work again. This refutes the conclusions of the many scholars who, based on a merely stylistic analysis, have argued that they belonged to two different periods: one Archaic and the other in Early Classical style.
Reversibility of the assembly has been ensured by interposing a so-called "intervention layer" whose adhesion capacity required laboratory tests to determine in advance whether tear resistance was affected by the presence of this film. Based on the weight of the head, the position of its centre of gravity and the inclination of the support surface, the results allowed verifying the joint's resistance. The three-dimensional model of the work and in particular its high resolution will prove to be crucial, when shared with the scientific community, in supporting stylistic and anatomical studies that will open up new avenues of research in the history of ancient art in Sicily.

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Diagnostic procedures before restoration of the statue of Sant'Oronzo and the Roman column in Lecce - Italy

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The Sant'Oronzo Colonna is one of the main monuments of Lecce Historical Centre. The column, 29 meters high, is from 2nd century AD and one of the two witch marked the end of the Appian Way in Brindisi. The wooden statue covered with copper at the top of the column, 5 meters high, was made in Venice and transported to Lecce to celebrate the first bishop of the town and patron of Lecce: Sant'Oronzo.
The statue and the column have undergone numerous restoration interventions over the centuries: the last around thirty years ago.
In this last intervention it was decided to carry out accurate diagnostic studies before carrying out the restoration
In this regard, accurate measurements have been made on the patina of the copper covering the entire statue by means EDXRF, XRD and Raman measurements. The same measurements were made on the patina covering the capital and the drums of the column.
A thorough endoscopic investigation was performed to ascertain the state of the wooden structure inside the statue.

Barbed male head, so-called "Head of Porticello" 460-450 BC

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technical / material: lost wax casting, bronze
dimensions: alt. 34.3 cm; width. max (front of the bandage) 19 cm; width. front to the jaw 17 cm; width. max profile 24 cm; average cast thickness measured at neck and neck 7-5 mm and beard 14 mm
provenance: Villa San Giovanni (Reggio Calabria), locality Porticello, probable submarine recovery of 1969
collocation: Reggio Calabria, National Archeological Museum (inv. RCM 1209)
restoration: Giuseppe Mantella

In November 1969, on the depths of the northern area of the Strait of Messina, at 35 meters of depth the so-called "relic of Porticello" was identified: a ship used for the transport of goods which, in the first decades of the IV century BC, was wrecked with its cargo.
On the day after the discovery, that precious cargo was the subject of illegal withdrawals. The underwater fisherman Giuseppe Mavilla entrusted the Superintendent with what he had reported on the surface. It was a group of 18 artifacts, among which bronze fragments stood out, corresponding to anatomical parts of at least two large statues. Particularly important was the delivery of the beautiful head, then called "Testa del Filosofo",
Soon there was news of the existence of a second bronze statue head, stolen from the wreck of Porticello. On the international market, the second head was long sought, until on 8February 1993, the Antikenmuseum of Basel, officially returned the precious bronze to the Italian State. The "Testa di Basilea" was sent to Rome to the Central Institute of Restoration for conservation interventions and scientific investigations.
The new intervention.
In 2017-18 a new project was planned, a program was developed that, from an operating point of view of maximum caution and gradualness, allowed first of all to ascertain the current structural stability and the conservative conditions. Visualization of internal and external surfaces, assisted by the aid of binocular microscope and field microscope, the stability of diffuse cracks and of the fractures present has been established, as well as the absence of particular criticalities mainly due to micro-fractures and thinning of the lamina.
It was possible to proceed, in complete safety, with the removal of residues of foreign substances still present on the surfaces of the product and the elimination of unstable corrosion products. The incrustations responsible for corrosion phenomena and not completely removed during the intervention of the ICR have been eliminated, after removal the consolidant; both through the mechanical action of scalpels, and through the aid of the laser, appropriately calibrated in order to make the intervention more selective, with a high precision and degree of control of the instrument. The work was carried out at the construction site in the National Archaeological Museum of Reggio Calabria and visited by thousands of tourists. The bronze head was part of the exhibition "RESTITUZIONI 2018" set up in Venaria Reale closed of the city of Turin.

The SILPI project: a system for determining the provenance of Calabrian rocks by image analysis

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The aim of the SILPI project (acronym of "Sistema per l'Identificazione di Lapidei Per Immagini"), financed by POR Calabria FESR-FSE 2014-2020 (Asse I – Promozione della ricerca e dell'innovazione), is the design and development of a smart system able to identify, from simple digital photographs, the different typologies of Calabrian stone materials and to determine their provenance.
The characterization and the determination of the provenance of stone materials, generally, represent a very long and complex process that requires not only the use of destructive and expensive diagnostic techniques, but also a specialized staff with a scientific and technical know-how able to interpret and process the compositional data obtained from the analyses. Instead, the system developed in this project is intended to be a tool that can be easily used by non-geologists (such as restorers, archaeologists, architects, engineers, diagnostics and art historians) by helping them to solve problems about the provenance and the classification of stone materials. The system, based on image processing, is developed using rocks sampled from different Calabrian quarries, some of which used in historical times for the construction of artefacts of historical and archaeological interest (Penta 1932; Dumon 1975; Cuteri et al. 2011). The identified quarries, located in the Calabrian territory, are representative of the five provinces (Catanzaro, Cosenza, Crotone, Reggio Calabria and Vibo Valentia) and they include several types of stone materials (magmatic, sedimentary and metamorphic rocks).
The rock samples, coming from the different outcrops, were sectioned to create flat surfaces which were acquired through several digitalization devices (smartphone, scanner and camera) under different lighting conditions. The system extracts, from each image, a set of representative features in terms of color and texture, after an appropriate phase of brightness and dimensionality normalization. Different classification modules, trained on the known image database, and recognition algorithms based on neural networks and/or support vector machines (Van der Heijden 2004; Haykin 2005) are being studied and tested. Early tests show strongly encouraging results.

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“I Cantieri del Suono” project: a public-private cooperation for the valorization of the violin “Piccolo” by Lorenzo Storioni (1793)

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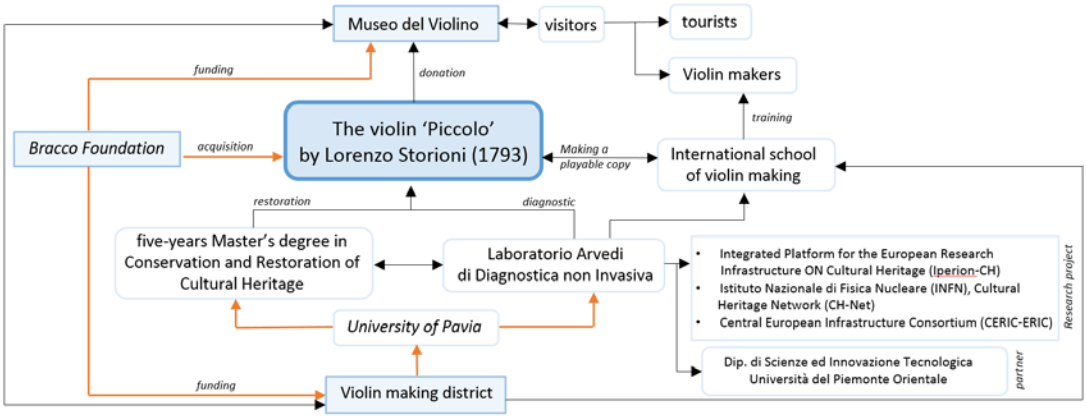
The Cultural District of Violin Making is a network of Cremona municipality that keeps the search for quality violinmaking alive and constantly strives to defend traditional craftsmanship. It coordinates various groups in the city involved in education, teaching and research in the field of music and violinmaking. The Bracco Foundation, one of the leading arts patrons in Italy, has chosen to finance the “I Cantieri del Suono” project, dealing with this highly promising area. One of the projects aims consists in the acquisition and valorisation of a rare violin made by Lorenzo Storioni (Cremona, 1744-1816), involving all the main organisations in the District, plus the violin makers that work in the city of Cremona. This small-size violin, known as “Piccolo”, was probably made for a child. The instrument was played in the decades following its construction (1793), but then it has not been used for a significant period. It provides an extraordinary piece of evidence when it comes to construction techniques, the materials used and the composition of varnishes in late eighteenth century Cremona. The analytical protocol developed at the Laboratorio Arvedi di Diagnostica non Invasiva allowed collecting new data on the instrument through a non-invasive approach (XRF and FTIR spectroscopy, X-ray radiography, VIS-UVIFL photography, 3D laser scanning, OCT, NMR). The obtained results were discussed with the students of the Master’s degree in Conservation and Restoration of Cultural Heritage, aiming at identifying the best procedures to preserve the instrument and its materials. Meanwhile, the students of the International School of Violin Making took advantage from 3D model, making a playable copy of the instrument. The violin and its copy will soon enrich the Civic Collections and will be exhibited at the Museo del Violino in Cremona. Up to now different strategies of communications have been put in place (publication of a monography, social network notifications, congress for experts in the field). During the exhibition, attention will be given to the diagnostic results, accompanying visitors through different levels of technical insights.



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Osteobiography of the people buried in La Sassa cave: an integrated bioarchaeological approach to deepen the knowledge of local Cultural Heritage.

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"La Sassa" is a karst cave in central Italy, where several unarticulated human skeletal remains were excavated from Copper/Bronze Age layers. An integrated approach, based on archaeological, osteological, isotopic and genomic data, will allow us to deepen the knowledge of the people that were buried and to correlate their features with those of other communities in central Italy. The osteological study points at a heterogeneous community, with children and adults with balanced sex ratio. A significant sample set was analyzed for carbon and nitrogen stable isotopes to identify trends in food intake by the people buried. Using a linear mixing model, the results point at a subsistence strategy mainly based on horticultural and breeding activities that may have induced specific biomechanical and pathological skeletal alterations. In spite of the extensive information already gathered by the multidisciplinary evaluation of the context, hypotheses on the geographic origin of the people buried inside the cave cannot be solely provided by osteology. The $^{87}Sr/^{86}Sr$ ratio of skeletal remains is known to be an important proxy for identification of the geographic origins. Therefore, we analyzed bone and enamel samples of humans and faunal remains and compared the results with those for water sources and soils in the surrounding area. The results suggest that the cave putatively hosts remains pertaining to groups featured by water supplies with varied geological characteristics. This evidence supports several hypotheses related to the funeral exploitation of the cave, which may have served
The biomolecular characterization of ancient DNA recovered from the bones and teeth submitted to isotope evaluation is currently being performed to establish the gender and the genomic make-up to understand some demographic-driven movements that could be responsible for making this complex scenario.
This integrated multidisciplinary approach represents an outstanding novelty in the archaeological evaluation of small communities scattered in Central Italy. Such novel bio-cultural understanding of a prehistoric community will be a valuable asset for the current local community, which has been steadily involved in the advance of the research through recurring meetings and public conferences. Indeed, this comprehensive knowledge would be a tool for promoting sustainable valorization of the local identity and for a proper valuation of this archaeological site in the frame of the national Cultural Heritage.

H2020 i-MARECULTURE project: advanced virtual and augmented reality tools for improving accessibility of the underwater cultural heritage

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The Underwater Cultural Heritage (UCH) represents a vast historical and scientific resource of highest importance for understanding the development of human civilization and, therefore, a fundamental and essential source for the upbringing and education of the next human generations. Unlike land archaeological sites, however, submerged settlements, ancient ports and other coastal industrial installations, especially shipwrecks, are not accessible to the general public nor all experts, due to their environment and depth. The research in the area of UCH focused mainly on documenting underwater CH assets. Although the documentation of underwater CH assets is a very important task, it's equally, or even more important, to communicate knowledge about documented underwater CH assets. To this end digital technologies (Virtual Museums, Virtual Guides and Virtual Reconstruction of Cultural Heritage) provide a unique opportunity for digital accessibility to both scholars and the general public, interested in having a better grasp of underwater sites and maritime archaeology.

In this context the Horizon 2020 i-MARECULTURE project (Advanced VR, iMmersive serious games and Augmented REality as tools to raise awareness and access to European underwater CULTURal heritagE), funded under the call 'Virtual museums and social platform on European digital heritage, memory, identity and cultural interaction' (CULT-COOP-08-2016), aims to develop and integrate immersive technologies and underwater augmented reality [1,2] for supporting the wide public in acquiring knowledge about the European maritime cultural heritage.

In order to achieve this aim the project combines different research disciplines, namely experts in 3D acquisition, Virtual and Augmented reality, serious games developers, geo-statistics and GIS, archaeologists, story tellers, along with technology of underwater tablets, holographic screens, in underwater sites and museums into one group. In this manner, it will accomplish existing technology to create breakthrough applications and digital experiences in the area of Virtual Museums in order to empower different types of users to engage with European underwater cultural heritage digital resources by exploiting reuse and re-purposing of existing data.

In particular, the project supports dry visits providing immersive experience through Virtual Reality systems that enable every user to explore some different underwater archaeological sites of the Mediterranean Sea without the need to conduct a proper dive. Furthermore, it aims to significantly enhance the experience of the diver by means of Augmented Reality system based on a specially designed underwater tablet that will serve as a virtual guide for divers that visit the underwater archaeological sites.

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The apsidal fishpond of *Castrum Novum* (Santa Marinella, Rome, Italy): preliminary archaeometric characterization for the MaTACoS Project

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This work is part of a research project titled MaTaCoS (Advanced materials and technologies applied to the conservation of underwater cultural heritage) funded by the Italian Ministry of Economic Development (MISE), concerning development of innovative tools and methods for the protection of Underwater Cultural Heritage, with particular regard to cleaning and consolidating procedures to be carry out directly in situ. The fishpond of the archaeological site of *Castrum Novum* (Santa Marinella, Rome, Italy) was chosen as a pilot site for experimentation. *Castrum Novum* was a Roman colony whose ruins are located between Torre Chiaruccia and Casale Alibrandi. The archaeological site lies on a wide area facing the sea, at the 64.4 km of the Aurelia State Road, in the Province of Rome, in a territory corresponding to today's Santa Marinella, which, during the Roman ages, belonged to *Caere*, now Cerveteri (Desibio et al., 2015). During the first half of the third century BC, it was one of the most important cities found along the ancient Etruscan coast as *Alsium* (now Palo Laziale) and *Pyrgi* (Santa Severa). Other significant remains, concerning the ancient city and the ancient harbour, lie close to the beach where now some modern stilts stand. The apsidal fishpond is one of these structures on the coastline. It is composed of only one tank, with an average immersion of 0.37 m below the sea level, and it develops with an NE/SW orientation. The masonry structures reach the maximum thickness at the apex of the fishpond (4.70 m) and consist of a concrete conglomerate composed of slightly rough stones of medium size bound with non-hydraulic mortar. After sampling, for a complete characterization of selected archaeological fragments, different and complementary techniques (stereomicroscopy, polarising optical microscopy and X-ray powder diffraction analysis) were carried out in order to: a) define the minero-petrographic features; b) investigate their state of conservation. The obtained data allow defining the main constituents of mortars from a compositional point of view. The raw materials, in fact, are quite homogeneous, as well as the ratio in which they were mixed, confirming the typical "recipe" used in Roman times to manufacture hydraulic-type mortars by adding *pozzolana*. At the same time, it was possible to identify the various degradation processes they are interested in, mainly, biological colonization (bio-fouling) that develops differently according to environmental conditions. From the applicative point of view, the textural, mineralogical and chemical information might represent the first step both for the definition of restoration interventions and for the planning of maintenance protocols.

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A modular ROV/AUV for submarine investigation an monitoring.

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We present a new ROV suitable for submarine monitoring and investigations. The ROV Is a multi-purpose vehicle and it was originally designed for routinely monitoring the keels of large ships and harbor basins. Of course, it can be immediately used in missions aimed to the investigation of the submerged archeological heritage. What makes this ROV different from other commercially available is its modular architecture. The basic configuration represents a very cheap device suitable for visual inspections down to -50 m. The boat is shaped as a torpedo 1 m long, with one propeller in the tail and four thrusters, two acting laterally and two vertically, which allow to control heading, climbing and to translate the ROV laterally. In such a way the boat is able for hovering in a fixed position. The buoyancy center is located on the top so no roll control is required. Such a characteristic, together with a residual positive thrust of about 50 g, allows for minimizing energy demands and the ROV is able of running for at least 5 hours under medium/heavy conditions. A full HD camera allows for movie recording and for the generation of 3D models of the submersed items. A Raspberry Pi3 lodged on the ROV takes care for communications via Ethernet to a surface PC while an Arduino Nano takes care for real-time control of the boat. The whole software is written in Processing 3 so it can be run over any operating system supporting Java.

The addition of multi-beam sonars can improve the system ability in working under poor visibility conditions. The geo-localization of the boat can be obtained by means of an acoustic GPS. This will allow the acquisition of fully geo-referenced data. The final goal will be that of producing a fully wireless and autonomous AUV. The ROV/AUV construction is carried on under the project SEAVIEW, FSR Sicily, whose goal is the fully integration of stereo photogrammetry images with 3-dimensional acoustic data obtained by means of a new multi beam sonar, developed ad hoc.

Geochemical characterization of glass tesserae in the Nereid Mosaic from Quartiere S. Aloe in Vibo Valentia-Calabria Italy.

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Remains of prestigious houses, streets and an important thermal building, dating in a time span from the first to the sixth century A.D., have been discovered in the archaeological area of the ancient city of *Vibo Valentia* – Calabria (Italy). The site covers about 30,000 square meters inside the *Quartiere S. Aloe*. The most important discoveries are related to the three beautiful mosaic floors found in a good state of preservation.
In this study the glass tesserae from the Nereid Mosaic have been examined by chemical analyses.
"The Mosaic with the emblem of the Nereid" came to light in 1982. It depicts a naked nymph riding a hippocampus surrounded by three dolphins. The emblem is framed with ducks and waders. The mosaic dates from the end of the II century A.D.
Before being recently restored a representative sampling of coloured glass tesserae from the Nereid Mosaic it was taken. The tesserae collection has been limited to a minimum: all samples were original tesserae erratically found during the excavation and not reused during restoration.
The characterization of glass tesserae was conducted through Electron Probe Micro Analyzer with energy dispersive spectrometer (EMPA-EDS) and Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS). The main aim was to determine the glass composition with the goal of throwing light on their production technology.
The ten tesserae studied here show a percentage of major oxides indicating the use of a soda-lime-silica type glass. In all tesserae, Potassium and Magnesium are below 1.5wt% as would be expected for Natron type glass produced in the Roman period, except for the "Nv4" green tessera.
All samples show an intense coloration, varying from green to yellow, from dark blue to light blue.
Considering that the different colors and their shades are due to the introduction of transition metals into the glassy matrix, their quantities, identified by LA-ICP-MS analyses, help to identify the coloring agents.
Copper is the main colorant in green tesserae showing also high concentrations of tin (Sn). In all blue-colored tesserae cobalt is the main colorant. Indeed, Co content in these is higher than in the other samples. In the end, the yellow tessera is characterized by smaller aggregates of lead antimoniates detected by EMPA-EDS analyses. Despite these new data are preliminary, it is possible to affirm that the geochemical study of glass tesserae provides important information about the techniques used for their production.

Investigating colours on a Hellenistic Gnathia-ware pyxis with lid from Morgantina, Sicily

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A Hellenistic Gnathia-ware pyxis with lid from Morgantina (Sicily) in a Sicilian private collection has recently been analysed by XRF portable spectrometer and digital optical microscope to investigate pigments and the painting technique. It's the first Gnathia vase from Morgantina ever analysed using non-invasive techniques.
The poster will display the unpublished results of this analysis, discussing them in the general context of the research "Morgantina a colori", an ongoing project focusing on polychromy in Greek items from Morgantina, the ancient Greek settlement in central Sicily.
In particular, the typical white, yellow and red overpainted decorations of this polychrome pyxis with lid were analysed using an XRF portable spectrometer. Moreover, analyses were also carried out on the black gloss surface and the ceramic bulk in order to characterize the contributions of the whole stratigraphy in the acquired XRF spectra. The contextual microscopic observations at high magnifications revealed the succession of application of the layers and documented the conservation state of the red layer, proving it was applied over a white layer, that's a typical feature of Gnathia pottery.
Further investigations can be helpful to understand if, compared to white and yellow layers, the fading of the pinkish layer is due to a different application method or to a greater thickness of the layer itself. Uniformity in terms of materials and technique was found between the pyxis and its lid.
These preliminary results allow to undertake a comparative study, especially with regard to fabrics and production centers, between the Gnathia pottery found in Sicily and the similar production of Southern Italy.



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Opus Sectile Glass Fragments from the Roman Villa of Aiano-Torraccia di Chiusi (San Gimignano, Siena)

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The roman Villa of Aiano-Torraccia di Chiusi (IV-V century A.D., Siena, Italy) represents a rare context in the panorama of Central Tuscany, as it belongs to a period generally considered poor of large roman residences and is located in a territory where the existence of these structures is still under discussion [1]. The sectilia glass fragments excavated at the Villa [2] represent a considerable corpus concerning both the number of fragments (around 1700) and the variability of colours and techniques. The relevance of the sectilia repertory was also suggested by the high quality of glass manufacturing and the large number of colour shades used to reproduce marine scenes.
Specific analytical strategies were thus required to deal with the huge number of samples during the conservation works and archaeometric studies, respecting at the same time the integrity of the materials.
The first steps of this multidisciplinary study were focused on the identification of the more suitable methods to remove any residues due to burial. Since dusting failed in removing the toughest deposits, the effects of laser ablation on such a heterogeneous repertory (both concerning materials and conservation) have been investigated. 3D optical microscopy and scanning electron microscopy (SEM-EDS) have been also used to check the effects of laser ablation on the original surfaces [3].
Due to their flexibility and low analytical costs, portable and non-invasive analytical techniques were also considered in order to provide a fast and quite accurate definition of the chemical and mineralogical properties of each sample and a first classification of the large number of pieces in compositional clusters. Portable X-Ray Fluorescence (p-XRF) and Fiber Optics Reflectance Spectroscopy (FORS) allowed a first definition of the chemical variability within the repertory and provided indications about both manufacturing and colouring techniques. The chemical-physical investigation allowed the characterization of raw materials, such as modifying agents (fluxes and stabilizers) and additives (colouring, opacifying and refining, together with intermediate oxides, where present), suggesting the use of a soda-lime glass with low potash contents, together with those colouring agents typical of the Roman glass industry. Higher contents in potash were detected in all the red samples suggesting the addition of plant ash as a flux.
Following this preliminary study, the reconstruction of part of the original marine scenes was possible and paved the way for a future exhibition of part of the repertory at the Museo Civico Archeologico of San Gimignano (Si). Here, a better understanding of the original decorations will be also supported by a virtual reconstruction thanks to a high-resolution 3D modelling.

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Protection of the stone of the Temple G of Selinunte. Investigation of the interactions between the substrate and the protective

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It is well known that the temple G is one of the largest in Selinunte (TP) and was among the largest in the Greek world, under construction from 530 to 409 BC but remained incomplete. The columns were built by using the "Cusa's stone", as shown by the existence of column drums of the same dimensions ten kilometres away at Cave di Cusa, still in the process of extraction.
The goal of this work is twofold: the investigation of the performance of three protective polymeric dispersions of different chemical composition on the "Cusa's stone" and the study of the interaction developed at the interface stone-polymer in order to connect macroscopic stone properties of coated stones with microscopic molecular interactions.
The stone samples were characterized by optical microscopy, mercury intrusion porosimetry, IR Spectroscopy, X-ray Diffraction and X-ray Fluorescence. The protectives have been chosen on the basis of the obtained results.
The stone samples were treated with the three protectives and characterized in order to evaluate the changes in the stone properties upon treatment with the dispersions.
According to UNI EN recommendations, the evaluation of the capillary absorption, of the permeability to the aqueous vapour and of the chromatic variation has been performed.
Finally, the interactions between the protective and the substrate have been evaluated by using solid state NMR Spectroscopy.
Results will be presented and discussed.

Figure. Cusa's stone samples (5x5x2 cm and 5x5x1 cm).

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The Ico Parisi's palette: preliminary studies

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Domenico Parisi (Palermo 1916 - Como 1996) was an important Italian architect and designer; the training years at the architectural firm of Giuseppe Terragni, where he attended many exponents of the artistic life of Como, and the meeting with Luisa Aiani, who will be for him a source of endless creativity and who will become his wife in 1947, were fundamental to his career. From his experiences and collaborations with main artists like Arman and Burri will descend the graphic research defined by Parisi 'tables of provocation', including two series: Apocalisse gentile and Crolli edificanti; precisely during the restoration of some painted panels of these two series and a canvas paper "Architettura dopo"(1985, serie of Sigilli) owned by Fondo Parisi Ico and Luisa, and exhibited in the hall dedicated to him at the Pinacoteca Civica del Comune di Como, in the Museum's warehouses, his original palette and two boxes of colours tubes are found.
The project to characterise the pigments used by Ico Parisi in his artistic production, starting from the material found, was born. The project, supported by the Rinnova Association and now outlining a thesis work in the course of restoration at the "Aldo Galli" Academy of Fine Arts in Como, begins with the study by non invasive techniques of colour tubes, then compared with those of the palette and the art works currently in the restoration lab. Approximately 90 layers have been examined, created with colours that are not yet polymerised, as well as small quantities of dried pigments taken from 12 of the tubes found. The preliminary results on the acrylic layers (Liquitex) presented in this work have been obtained by Vis-NIR Reflectance Spectrometry in the range of wave lengths between 400 and 1000 nm. All the analyses, both on the palette and on the works, were performed in the rooms of the gallery.
This first part of the project allowed not only to define pigments and mixtures used by Parisi in his artistic production, but also to start a work of scientific documentation of some commercial products typical of post-war art. The developments of the project, currently underway, include both the retrieval of bibliographic documentation on Liquitex colours and the expansion of the analysis on the pictorial layers, both invasive and non-invasive.

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Detecting the NIR fingerprint of colours: the characteristic response of blue pigments

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Reflectance spectroscopy (RS) in the UV, visible and near IR range (UV-Vis-NIR) can be successfully applied to art studies for the characterization of paints and pigments, with the advantages of non-invasive techniques [1]. Reflectance data can be a support for subsequent studies about the stratification of the pictorial layers and the historical evolution in the production of pigments in paints can be obtained [2]. Moreover, it is of wide interest to distinguish the optical response between the paint layer and the support of an artwork, as well as between the different pigments, binders and dyes used for its realization [3].
In the NIR range, most of the common organic functional groups (e.g. -OH and -CH) are involved in vibrational transitions [1, 4], so that relating the optical spectrum of a composite sample (as an artwork) to each one of its elements (i. e. support, specific pigment and binder) is not trivial.
Here, a strategy is proposed for the evaluation of the applicability of RS, consisting of the investigation of model samples, both bulk colours and samples simulating artworks, realized by using modern acrylic colours and pigments. A method is presented to obtain the UV-Vis-NIR optical response of the single components of a model composite sample, i.e. the support, the binder and the pigment or dye, by using diffuse RS. This allows to isolate and detect the spectral fingerprint of pigments, especially in the NIR range, where a deeper analysis of the characteristic absorption bands of blue pigments is carried out.

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Characterization of powdered pigments for pictorial retouching by means of spectroscopic techniques

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A set of 27 commercially available pigments by *Kremer Pigmente* (Aichstetten, Germany), including traditional and synthetic compounds, has been characterized in detail from a chemical and mineralogical point of view by using three different analytical techniques: Raman, FT-IR and Fiber Optics Reflectance Spectroscopy (FORS). These pigments are well known to museum conservators and restorers for pictorial retouch purposes of both ancient and contemporary works of art: a deep comprehension of their composition is consequently fundamental in order to better understand their long term behaviour once applied.
The investigated pigment set is classified by the company into 4 categories: 1) dyes and colors from plants, 2) pigments of own production and historical pigments, 3) modern pigments and 4) natural earths. Recorded spectra were interpreted in order to identify existing phases and obtained results were compared with data sheets available by *Kremer Pigmente*: several inconsistencies were found (especially concerning pigment CAS numbers), together with the absence of some compounds in their records.
Most of Raman and FT-IR peaks were attributed, even if in some cases only related chemical species could be identified, while information regarding individual vibrational modes was not found in the literature. The same applies to recorded FORS spectra.
On the basis of obtained data a related database was eventually generated, reporting characteristic features of phases identified in every analyzed pigment in order to provide a useful tool for the study of real artworks.

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San Gregorio polyptych by *Antonello da Messina*: a diagnostic campaign on the state of the artwork conservation

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Nowadays, the study on cultural heritage materials is a very promising field in chemistry. The characterization of these ones employed in the artwork manufacturing process has become a common procedure before any kind of restoration in museums and institutions involved in the conservation of finds of historical and artistic interest [1].
The knowledge gained over the years about this topic and the use of modern instruments lead us to understand the chemical reactions implicated in several processes, such as the degradation of a find, and allow to evaluate the conservation state of artwork or buildings.
In the light of these considerations, the present communication aims to show the result obtained during a diagnostic campaign of measurements conducted on the San Gregory polyptych (shown in the picture), painted by the Italian Renaissance master Antonello da Messina and housed in the Regional Museum of Messina.

The painting has been studied by non-invasive investigations in order to evaluate the conservation state before moving to the temporary exhibition "Antonello da Messina" in Palermo (Palazzo Abatellis, 14 December 2018- 10 February 2019). This exhibition is the largest dedicated to Antonello da Messina containing half of his existing works.
More in detail, a Raman and X-Ray fluorescence (XRF) spectroscopy study was carried out with the aim to identify the molecular species, organic and inorganic respectively, present in the pictorial layer both in the pigment and binder form.
Raman and XRF spectroscopic analysis were performed by means of a Bruker BRAVO Handheld Raman Spectrometer by Duo LASER, which works with two excitation lasers with wavelengths located in the range 700 - 1100 nm, in order to mitigate the fluorescence phenomena, and a Tracer III SD Bruker AXS having a Rhodium tube as X-ray source, respectively.
In particular, for each painting, the most representative pattern was analyzed both on the original defined areas and on the subsequent repainting / restored ones. In order to ensure the complementarity of the results between Raman and XRF data, the spectra were acquired on the same measurement points and the results were reported in this work. For both techniques, the identification of the collected signals was made by the comparison with a database of reference materials [2].
Moreover, thermal analysis, IR reflectography and Uv fluorescence investigations were carried out to study possible detachments in flat wood panels and map the subsurface layer of the artwork.

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Preliminary contribution on the conservation state of the *domus domini imperatoris Apicii* built by Frederick II along the Ancient *Via Appia* (southern Italy)

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Domus domini imperatoris Apicii is one of the most representative palace built by Frederick II in *Principatus et Terra Beneventana* (Campania, Italy), along the Ancient roman *Via Appia*, strategically used to reinforce the defence line of the border with the State of the Church.
Recent studies (Furno et al., 2018), based on the methodological approach of Building Archaeology, highlighted a constant use of the *domus* between the 1240 to the present. The well documented history of the monument, as well as stratigraphic analysis applied to the study of the standing architectural remains, provided an important starting point for a reliable evaluation of the conservation state as a function of the building materials (stones, mortars, bricks, etc.) and their response to the environmental conditions.
In this contribution some preliminary results about damage diagnosis of *domus domini imperatoris Apicii* were reported following a standardized method of diagnosis (Fitzner & Heinrichs, 1996). For this purpose, a quantitative evaluation and distribution of geomaterials, weathering forms and damage categories was carried out. An accurate mapping was performed on high resolution orthoimages provided by a photogrammetric survey (Furno et al., 2018). Results indicate a heterogeneous distribution of geomaterials within five building phases: calcirudites (*spolia* roman marble) and trachytic pyroclastic rocks (likely Campanian Ignimbrite outcropping along the Calore river) during Fredrick II and Angevin construction periods; fluvial boulders (mainly limestones, sandstones and flints from sub-rounded to subangular) during the Aragonese, 1700's restoration and contemporary periods. Weathering forms were not only affected by the mineralogical composition and petrographic features of geomaterials, but also by the exposure of the examined facades, which promoted the biological colonization by plants, lichens and mosses on the north-west oriented masonries.

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Ceramic forgeries aged by radiation: towards a new method for their identification

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Thermoluminescence (TL) is a powerful tool for authenticating ceramic artifacts, with an accuracy of ±20-30% that is generally sufficient for differentiation between genuine objects and fakes [Aitken, 1985]. However, one of the biggest problems about the great diffusion of TL as dating tool is that counterfeiters have learned in time various tricks to mislead the authentication. Whereas the assembling of old and new parts or the carving from ancient but worthless artefacts can be quite easily discovered by means of other techniques, the "aging" of an object induced by artificial irradiation with X or γ rays cannot be detected with certainty so far [Neunteufel, 2010].

The chosen approach for overcoming this issue is the observation of the effect of α particles irradiation on the quartz grains contained in the clay matrix. This kind of irradiation is only present in naturally irradiated samples, and almost impossible to reproduce without the availability of an α radioactive source. An α particle is a Helium nucleus (He^{2+}) with a significant mass, higher than for β or γ particles and hence capable of inducing lattice damage. Since the penetration range of an α particle is smaller than those of β or γ ones, only the surface shell of quartz crystals is involved with the interaction and could show the characteristic traces. In geology, the effect of alpha particles on quartz is well known as the consequence of constant irradiation, for millions of years, of the portion of crystal surrounding radioactive inclusions, in particular Uranium and Thorium. The visible effect results in the formation of a luminescent halo, easily detectable with cathodoluminescence (CL) imaging [Owen,1988].

Preliminary results of this new method will then be presented, including strategies for quartz grains isolation and comparative CL studies of the selected grains, performed before and after the irradiation with an α microbeam at different particle energies carried out with the AN2000 accelerator at the INFN - Laboratori Nazionali di Legnaro facility.

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"Stone tools as bioarchives" An integrated multi-scale contextual approach

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This pioneering multi-scale approach to museum artefacts' biographies is applying research methods and conceptual frameworks on a multidisciplinary basis. It is focused on Palaeolithic stone tools which represent powerful evidence of cultural traits. By applying surface texture analysis to reconstruct stones utilization and it was possible to recognize as well remanences of biogenic residues related to food processing. Therefore stone tools are preserving both the tangible and intangible evidence of past behaviour. The research allows to develop the innovative concept of "Stone Tools as Bioarchives", which calls for a totally different look at the behavioural, biological and environmental elements that are expressed by human material culture and radically change our understanding of it. This innovative way to look into stone tools demonstrates they are rich and unexpected bioarchives, with a high diagnostic potential to reconstruct environments, patterns of land use, and dietary habits of the past humans.
These data, largely unspoiled because until present mostly investigated from morphological or techno-typological perspectives, are actually housed in museum collections. The test-case presented here comes from the Szeletsian site of Brinzeni I cave, an impressively well conserved, sizeable assemblage of 33 grinding stones housed at the National Museum of History of Moldova in Chisinau. Brinzeni I was selected for this venue because it represents the largest sample among more than 20 sites, already analysed by this team, and its results are further supported by tens of other examples, which will be discussed in other venues.
The functional study of grinding stones demonstrated the presence of use-related starch granules processed to get highly calorific food, highlighting the breakthrough evidences for starchy plants processing dating back to the Aurignacian, the oldest culture attributable to Homo sapiens in Europe.

In order to characterize these residues we develop an integrated multi-scale contextual approach to stone tools analysis which include both micro and nano scale heuristics (forthcoming publication). Very significant information is gained from (i) using several microscopies (including Digital and SEM), (ii) FTIR imaging and microscopy with IR Synchrotron Radiation (SR) and conventional sources, (iii) ToF-SIMS and (iv) Isotopes analyses conducted on the same biogenic samples, (v) AMS dating to ~32 kyr (uncal BP).
Potential starch granules were first selected by visible microscopy (Optical, OM) and then imaged in order to retrieve their spectral features. The very same sample ROIs were then subjected to SEM observation which allows for the recognition of the starch typical morphological features like lamellae and hilum. Accordingly, the same granules had been re-analyzed with IRSR FTIR mapping, in order to validate SEM and spectra observations. The established procedure is providing evidences of the morphological and chemical features characterizing ancient starches, and demonstrated to be a valuable tool for discriminating modern contaminants.
ToF-SIMS (Time of Flight Secondary Ion Mass Spectrometry) has been applied on the ROIs samples to study the surface chemistry of starch granules. In fact, the presence of certain "minor components" (e.g. proteins, lipids, etc.) might characterize their association with specific botanic origin's granules. ToF-SIMS allows to detect organic and inorganic constituents of the sample surface. This is accomplished by using a very low energy ion beam that bombards the sample and generates secondary ions from the first few nanometers of surface, resulting in a very low invasive analytical technique, suitable for the archaeological samples.

The isotopic characterization of the biogenic residues is bringing lines of evidence for the photosynthetic pathways of the plants pounded at Brinzeni I cave, around 32 uncal BP. Since plants are different in their efficiency at gathering carbon dioxide and utilizing nitrogen from the atmosphere and in the soil, C_3 or C_4 plants shows different nutritional compositions namely in carbohydrates and proteins, it is crucial to figure out which of them were available for human nutrition during the colder stages of MIS 3 (Marine Isotopic Stage). In term of plants processing it is relevant to collect data regarding the presence in the Brinzeni landscape of plants (abovesurface biomass (AB) and undersurface storage organs (USO)) that can be source of food for the humans and their putative differences in nutrient digestibility. Moreover isotopes can inform on CO_2 .
The contextual analyses briefly mentioned above (i) allows to establish protocols to retrieve, analyse and conserve use-related biogenic residues (i.e. starches from grinding stones), (ii) brings in the spotlight the fact that hard sciences are evidencing unprecedented data instructing upon invisible traces of practices (i.e dietary habits), (iii) informs archaeologist and museum curators that such rich and delicate "palymsepst" of data calls for a new concept towards stone tools biographies and their management, streamlining standardized procedures from the excavation to the museum shelves. The multi-scale contextual approach we developped represents a remarkable step in the direction of bridging the chasm still in vague between humanities and hard science, making sense of applying sophisticated heuristics in order to unfolding the complexity of food habits at the dawn of modern humans' colonization of Eurasia.
Museums and their rich collections are the place where this reconciliation can take form, the intellectual mileu where the chasm between humanities, STEAMED science and digital technology can be faced, elaborated and possibly overcome.

Combining OCT and NMR-MOUSE techniques to study the stratigraphy of historical violins: the *thickNESS* project

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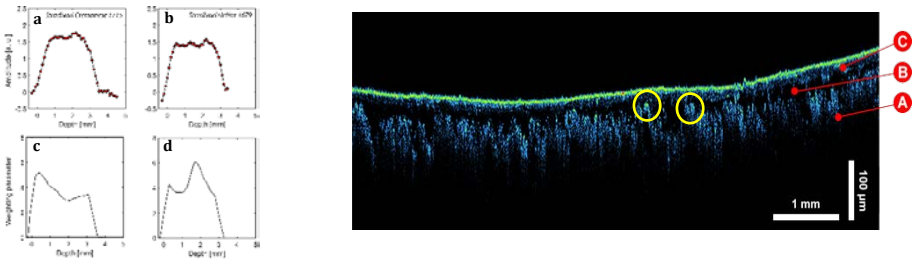
In this work, Optical Coherence Tomography (OCT) and Nuclear Magnetic Resonance (NMR-MOUSE) have been applied to precious historical violins made by the most renowned makers of the Italian lutherie, such as Amati, Stradivari and Guarneri 'del Gesù', and hosted in the Museo del Violino in Cremona. Several large fragments removed during past restorations from instruments produced by the luthiers Stainer, Gasparo da Salò, Maggini and Guadagnini, as well as laboratory models simulating musical instruments stratigraphy, were further examined. OCT study was carried out with a prototype high-resolution portable SdOCT instrument providing layer thickness measurements and information about the presence of particles, cracks and delaminations. NMR analyses were performed with a Magritek Kea spectrometer and a Profile NMR-MOUSE (PM5) giving information on the wood density and elasticity, the last one possibly related to adopted treatments. The analyses have been conducted within the MOLAB Transnational Access - EU H2020 Project IPERION CH (thickNESS Project).
Data interpretation is still in progress and promising results are expected to reveal in-depth insight into the finishing violin making process. These outcomes will be integrated with the results from UVIFL, FT-IR, Raman and XRF techniques in order to set up a methodology which allowed researchers to non-invasively characterize the stratigraphy of historical violins.



Left: NMR depth profiles from the Cremonese (a,c) and Hellier (b,d) violins. The NMR signal amplitude (a,b) is governed by the wood density; the weighting parameter (c,d) is governed by the material properties, most importantly elasticity. **Right**: OCT tomogram of a fragment by Gasparo da Salò. The wood substrate A, the varnish layer B and the external layer C are shown. Particles embedded are highlighted in yellow.

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Painting materials and decay phenomena in urban art: the case of the Urban Art Museum in Turin

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In the last few years urban art is gaining an important place in the urban fabric and for the citizens too, but both scholars and professionals in the field underline a lack of knowledge about its conservation and protection [1,2]. At the beginning of 2018, the European Commission has funded the *Conservation of Art in Public Spaces (CAPuS*) project (Programme Erasmus Plus - Key Action 2: Cooperation for innovation and the exchange of good practices - Knowledge Alliances) which main goals are the development of guidelines for the protection and the conservation of urban art, and the introduction of an innovative training module in higher education institutions focused on this topic [3].
In the last 20 years, Turin has become a particularly active and prolific city in the urban art scene [4]. The city has hosted several street art festivals and other initiatives of urban art, supported by the Municipality of Turin and co-organized by associations of street artists. In addition, Turin also hosts the Museum of Urban Art (MAU), an outdoor museum located in Borgo Vecchio Campidoglio, a working-class district still conserving its original urban structure characterized by small houses and narrow streets. MAU is an interesting example of street art museum characterized by an *open air* itinerary that winds through more than 147 artworks by 96 artists. Thanks to the strong cooperation among artists, artisans and traders, the artistic collection of MAU constantly grows, and it is carefully preserved by the great engagement of MAU director and collaborators. Structured interviews were made with artists who collaborated with MAU to collect their experience and to better outline the unconventional reality of MAU. This activity was preliminary to the scientific analyses carried out on some of the artworks and aimed at the identification of the painting materials and at the study of the degradation phenomena of the preparatory and pictorial layers. Some preliminary results of the diagnostic campaign carried out on a selection of artworks, including two murals, a painted metal panel and several painted wooden benches, will be presented.

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Appearances are deceiving. The small mummy with coffin from the Museo Egizio in Torino (cat. 2247/2): many approaches to support its interpretation

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This work presents the results obtained by non-invasive and micro-invasive techniques performed on a small mummy (30x10 cm) contained in a wooden coffin with trapezoidal shape, also of small dimensions (40x15x11 cm). The mummy is part of the collections of the Museo Egizio in Torino [1] and belongs to a set of four similar mummies classified in the first catalogue as "little mummy of human form" and later as "mummy of a child in a coffin", referring to the results obtained from previous radiographic analyses. The provenance is unknown and the dating is still debated, being the artefacts probably composed of reused elements belonging to different periods. In particular, the cassette and the cartonnage show comparisons with the Tolemaic-Roman periods.
The mummy was compared with similar artifacts published in recent works [2, 3] and investigated using the following non-invasive techniques: Computed Tomography (CT), Visible Induced Luminescence (VIL), Fiber-Optic Reflectance Spectroscopy (FORS) and X-Ray Fluorescence (XRF). These investigations were then followed by the analysis of micro-samples with infrared microscopy (μ-FTIR) in a diamond cell.
What emerged so far from the analysis actually supported the hypothesis that the mummy could be an assemblage of re-used materials, with different parts coming possibly from different areas in Egypt. Moreover, further information emerged. The mummy is wrapped in numerous layers of bandages, with cartonnage fragments decorated with styles and pigments related to the Roman period applied over them. In addition, a mask produced in modern times is present. Also the polychrome decorations of the coffin would be coherent with an ancient production, but some metal nails detected by X-ray radiography testify that the assembly has been done in much later times.

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Spectroscopic and thermographic surveys in the church of S. Maria delle Palate di Tusa (ME)

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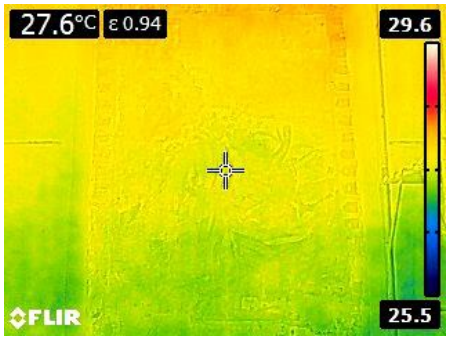
The church of S. Maria delle Palate is located on a hill overlooking the coast, in the municipality of Tusa, in the province of Messina, within the archaeological area of the ancient Halaesa Arconidea, a city founded in 403 BC and abandoned around the tenth century AD.

The building, whose original phase could date back to the Byzantine period, is mentioned for the first time in a document dated 1123 with the title of *Sancta Maria*, which later became the *Sancta Maria de Palatio* (or in the vulgar form S. Maria de li Palazzi), toponym that will indicate over time the entire area in which the remains of the ancient city are preserved.

The structure visible nowadays is the result of a rebuilding, on the remains of the Norman church, dated to 1551 and of two successive consolidations occurred one between 1734 and 1753, under the bishop Giacomo Bonanno, and the other in 1978, made by the *Genio Civile* of Messina. Inside the church there is a wall painting, probably representing St. Francis in the act of receiving the stigmata, on which thermographic investigations were carried out aimed to identifying possible thermal anomalies and degradation processes in progress. We used a FLIR-EX system for thermographic analysis, it is a compact portable camera with an acquiring range from -20 to 500 °C.



Moreover, a combination of non-invasive analysis by using handhel spectroscopic instrumentations (XRF and Raman Spectrometers) was applied in order to characterize the pigments and binders used for the realization of the painting. XRF spectra were acquired by using a Tracer III SD Bruker AXS instrument, and data have been analysed by using the software ARTAX 7. All the Raman spectra were acquired with the latest generation of Bruker Bravo handheld instrument equipped with Duo-Laser system.

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Raman characterization of clay masks at Archaeological Museum of Lipari

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The Archaeological Museum of Lipari "L. Bernabò Brea" is located on the rocks of the "Castle" of Lipari, an imposing dome of volcanic formation with characteristics of natural fortress. The museum of Lipari preserves a large collection of masks and statuette of the Greek world that allows visitors to learn about the civilization theater from the era of the great tragic Aeschylus, Sophocles, Euripides and Aristophanes to Menander. [1]

The poster deals with the study of pigments on some clay masks. The analysis of pigments on artworks is of major significance in art conservation as it leads to detailed characterisation of materials. To this purpose we used Raman spectroscopy, a non-destructive technique capable of analyze dyes and pigments in the cultural heritage field. The tecnique is able to investigate materials used on works of art because it is very reliable, sensitive, specific, nondestructive and can be applied *in situ*, therefore avoiding any sampling and consequently any damage to the object under examination.

The clay masks have been analysed by portable Bruker – BRAVO Handheld Raman Spectrometer equipped with licensed DuoLaser system and an algorithm able to mitigate the fluorescence, providing reliable and quality spectra on both inorganic and organic substances. (SSE™, Sequentially Shifted Excitation). The Raman spectra are acquired in 300-3000 cm^{-1} spectral range and processed with OPUS software; identification of the collected signals is made by comparison with a spectral database [2] of reference materials.

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Scientific research supporting the study of pigments and dyes in Armenian miniature painting art

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Mesrop Mashtots Institute of Ancient Manuscripts is one of the largest medieval manuscripts and books in the world. He owns the mandate for the preservation, restoration, reproduction, procurement, cataloging and publication of important Armenian manuscripts.
Today, approximately 20,000 medieval manuscripts preserved in the Matenadaran need deeper study because it has not been possible to study the medieval manuscripts of inks, pigments and paper and parchment chemical composition so far, which will contribute to the more conservative conservation and restoration of damaged manuscripts. Different fragments taken from different miniatures in the manuscripts were analysed by means of UV-Visible diffuse reflectance spectrophotometry with optic fibres (FORS), fluorimetry, Raman spectroscopy, SERS and SEM-EDX. The combination of molecular and elemental techniques allowed the characterisation and identification of colourants used in miniatures; these were carbon, cinnabar, indigo, iron-gall ink, orpiment, red lead, ultramarine blue, vergaut, white lead and naturally Armenian cochineal (*Porphyrophora hamelii* (Brandt)
The researches carried out in collaboration with the Restoration Division of Matenadaran in Yerevan and the University of Rome's La Sapienza, Dr. Yeghis Keheyán in the last twenty years give the exact conclusions on the valuable medieval pigments, inks, papers and parchment structures and their originality therefore helping Museum to use these findings for synthesis , conservation and preservation problems.
The works in this field continue, there are differente scientific articles.

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Architectural elements from the Roman age harbor of Lipari Island (Aeolian Archipelago, Italy): petrographic evidences for the use of Fuardo stones

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Ancient harbors and the surrounding life represent evidences of civilizations, particularly of the Roman age, that is our focus here. We have studied architectural elements probable column bases belonging to the ancient submerged port installation of the Lipari Island (Aeolian Archipelago) – presently preserved at the Lipari Museum – with the aim to confirm the possible use of local stones from Fuardo Valley for their realization, as previously hypothesized by archaeologists and Tisseyre (2010). Submarine surveys were carried out in 2010 by the Sicilian Soprintendenza del Mare and the INGV at Marina Lunga, Lipari Island (Italy). Large submerged remains were found and assigned to the Roman age on the basis of the typological features of the recovered pottery fragments related to II -III sec. AD (Anzidei et al., 2016). In particular, three architectural elements and several structural elements of the port were discovered (Anzidei et al., 2016).

The architectural elements – made by volcanic rocks – have been sampled to define the provenance of the raw materials. Their analysis was performed by means of a petrographic/mineralogical investigation based on optical microscopy in transmitted polarized light (OM) and scanning electron microscopy with energy dispersive spectroscopy microanalysis (SEM-EDS). Moreover, the data obtained on the ancient findings were compared to those reported in literature on cordierite-lavas from the Fuardo Valley (Lipari).

Our results indicate that the used stones are compatible with the cordierite-lavas flow of S. Angelo Mt., outcropping in the Fuardo Valley, in the south-west area of the Lipari Island. The use of these rocks as building material was already attested for other Greek age artefacts (walls and sarcophagi) found in C.da Diana at Lipari Island, although no historical sources refer of any mining or working activities in the Fuardo area.

The overall results of this work, together with some traces indicative of working activities observed by archaeologists and detected by dott. G. Sabatino and Prof. M. Triscari in 2016 (UNIME - personal communication) on the outcrop at Fuardo Valley, suggest that the cordierite-lavas flow was extensively used as a quarry area during the ancient time and improve our knowledge about the use and exploitation of the local resources at Lipari Island during the Imperial Roman age.

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pH effects on SERS active substrates prepared by Pulsed Laser Deposition

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Surface Enhanced Raman Spectroscopy (SERS) is a useful technique to characterize organic pigments in a non-destructive way, and, respect to conventional Raman Spectroscopy, avoiding fluorescence emission which commonly is shown by this class of substances. [1] Moreover, SERS technique may provide useful qualitative information in terms of molecular composition even when dealing with low concentration components and this is very appreciated if compared to the sensibility of most molecular spectroscopy techniques, when having to deal with a very low quantity of analyte can lead to low analytical performances. [2] Due to the value of this technique, it has been considered if the pH of an aqueous media could alter SERS effects in some way, *e.g.* influencing the adsorption of molecules on the metallic surface as a result of protonation effects. To investigate this point gold and silver nanoparticles (NP) obtained by Pulsed Laser Deposition (PLD) [3-5] have been deposited on glass slides and micrometric grit polishing paper sheets. SERS efficiency of these substrates has been tested using an aqueous solution of Rhodamine 6G (R6G), a standard molecule which is SERS-active but very weakly Raman-active. Measurement were done after immersion of the substrates in aqueous solutions of R6G at concentration of $2{,}5 \cdot 10^{-5}$ M having pH 3, 7 and 11. Signal amplification, with respect to untreated glass and polishing paper substrates, has been observed both for Ag and Au. SERS effect is 10 times higher for Ag based substrates compared to Au based substrates. Despite that, the entity of the amplification is influenced by the pH of the aqueous media apart from the type of NP. Respect to neutral pH, alkaline treatment led to a higher enhancement on all the cases, whereas acid treatment lead to a higher effect on Au based substrates and a lower enhancement on Ag based substrates.

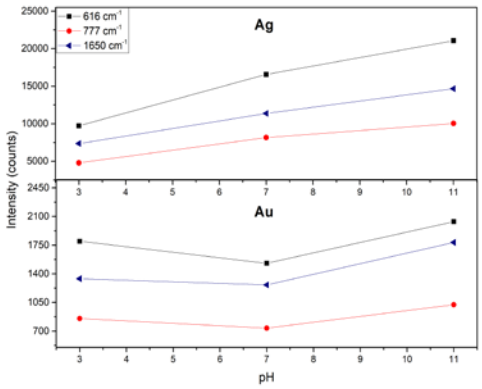

Fig. 1: Intensity of selected R6G Raman peaks as a function of pH. Measurements on SERS-active polishing paper.

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PEO-based nanostructured polymer systems as a cleaning agent of artworks

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The search for innovative, smart and performing cleaning agents in the field of cultural heritage is one of the main issues of modern conservation science. The development of novel smart nano-structured cleaning systems requires the comprehension of their structural behaviour and interactions with other materials down to the nanoscale in a fluid environment. Complex fluids based on amphiphilic formulations such as micelles, microemulsionsand (hydro-)gels represent emerging materials, in the field of conservation of artworks, as safe and effective nano-structured systems for the removal of hydrophobic polymeric coatings. In this respect the comprehension of the cleaning mechanism represents a key information for the design and engineering of tailored fluids for this purpose. Despite the number of recent studies in this field, the mechanism and the interaction processes between nanostructured fluids and hydrophobic polymer films is still poorly understood. We report on some recent results from a study about the mechanism of the cleaning process (organic components removal) using nano-structured materials consisting of PEO-based micellar polymer systems of block copolymer polydimethylsiloxane-b-polyethyleneoxide (PDMS-PEO). The main features of the obtained results may help to identify the main relevant parameters that influence the increase of the rate and efficiency of the cleaning process. A full understanding of these complex processes will open new possibilities for a novel approach to conservation of cultural heritage.

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Microclimatic analysis in museum showcases

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In modern museums, most of the objects are exposed inside showcases whose microclimatic conditions depend mainly on two factors: the physical properties of the materials composing showcases and the outside microclimatic conditions. Recently, the authors studied the microclimate in a museum hall of the Physics Museum, University of Torino (Ferrarese et al., 2018) showing that also the local position of the showcase in the room is a significant factor. They suggested an index to compare the microclimatic conditions inside and outside different showcases.
In this work, the study is extended to the analysis of microclimatic conditions inside and outside the showcases under different heating systems in the room and in particular when the heating system is off in the warm seasons. Our goal is investigating if the analysis of residual data in the time series of temperature and humidity can give more information about microclimatic variations with respect to the daily excursion of the same variables.

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Geological and Cultural Heritage: dissemination experiences in Tuscany

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We report our recent experiences of scientific dissemination activities on geomaterials utilized for various purposes in our territories. The primary aim of this work was to stimulate an exchange between various research organizations (universities, public research institutions, museums, associations, etc.) and the civil society. In our experience, the interaction of researchers from different institutions with their multidisciplinary skills has been fundamental to affirm the idea that scientific research and technological innovation are crucial, to make geological and cultural heritage and knowledge easily usable and widely disseminated. The main message we would to give is that the most "insignificant" rocks (or those commonly used, e.g. the bar or kitchen countertops) store in their interior very useful information beyond the beautiful colors and their aesthetic appearance. These rocks can tell stories about other times; their structures, chemical and mineralogical compositions, shape, color and texture will provide clues about previous geological events. Moreover, the rocks used in urban architecture and monuments are an inexhaustible archive that contains a lot of historical and economic information on the development of a city and its surrounding area. The role of a geologist, in this context, is to provide to the public, in very simplified and attractive language, the tools necessary to solve the puzzle (i.e. learn to identify the most important minerals, know their physical and chemical properties, and discover the environments in which they form).

For these purposes, we have experienced various type of outreach, training and dissemination activities, such as scientific exhibition with guided tours, thematic conferences, city walks, training courses and workshops. All the activities were open to students of all levels, academic audience, passionate, experts and always the audience was very large.

To mention some examples: 1) "Anche le Pietre Parlano" exhibition, conceived and realized by the IGG-CNR, of some four hundred specimens of rocks normally used as ornamental stones quarried from the whole world and predominantly from Italy. The exhibitions were supported by 20 explanatory panels and visitors enjoyed the accompany of an expert guided tour. After the great success at Villa Borbone (Viareggio, LU), the event was hosted first at Villa Bertelli (Forte dei Marmi, LU) in the framework of "Che Forte, la Scienza!" a festival of scientific culture and successively at a high school of Boario Terme (BS). 2) In the framework of "Settimana del Pianeta Terra", a national program for the diffusion and dissemination of the Earth Sciences, we organized different activities such as: a) walking in Pisa and Lucca to recognize the rocks of the historical buildings (DST-UniPi); b) temporary exhibition of ornamental stones at the research area of Pisa (IGG-CNR); c) thematic conference and city walk titled: Territory, geo-resources and cultural heritage: examples of 'Urban Petrography' in Sicily and Tuscany, IGG-CNR in collaboration with the Museum of Mineralogy (DiSTeM, UniPa). 3) During the international "European researchers' night" a "treasure hunt" for children was organized at the Villa Borbone garden. The young aspiring geologists were capable to identify the rocks they find while playing. 4) "Alternanza Scuola-Lavoro" (Italian Ministry of Education) training project for high school students, 5) CoRRo project (funded by Fondazione Banco del Monte di Lucca) is a training course for medium and high school teachers.

The next challenge is titled "Le Pietre di Pisa", a multidisciplinary workshop for all levels students, hosted by the "Ludoteca Scientifica" (an interactive scientific exhibition promoted by UniPi, CNR and many other scientific institutions and associations operating in Pisa), associated to a walk through Piazza dei Miracoli and the recently opened to the public walkway on the City Walls of Pisa, to discover their "stones" that tell of journeys, imports, plunders and local mining activities.

Open for restoration. Conservation as experience and shared responsibility

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The "Centro Conservazione e Restauro La Venaria Reale (CCR)" foundation was born in 2005 as an institute for higher education and research in the field of restoration and conservation of cultural heritage and it is based in the Reggia di Venaria complex. According to the statutory purposes of high education and research, CCR is made of different departments: the School of Higher Education and Study, the Conservation and Restoration Laboratories, the Scientific Laboratories, the Library. The agreement signed in 2006 between CCR and University of Turin started the five-year Master's degree course in Conservation and Restoration of Cultural Heritage.

In 2015 CCR has launched the *Open for Restoration* project aimed to promote an aware and responsible knowledge of cultural heritage and to promote the skills and professions involved in conservation and restoration activities.

The different departments of the CCR participated in a critical reflection to define both the instruments of mediation (lexicon and methods of engagement and reception of the public) and the contents to be transmitted according to the recipients.

From exclusive and closed places, the Conservation and Restoration Laboratories and the Scientific Laboratories have become a place of participation, inclusion and meeting for students and local schools within paths and activities characterized by the presence of conservation scientists and restorers.

In the four years of activity, the didactic paths and the educational meetings offered to schools underlined how interdisciplinary, technological innovation, scientific research and cooperation are the basis of a shared methodological approach for conservation and restoration of cultural heritage. It's no coincidence that these paths are the result of a team work of professionals characterized by different skills.

From scientific investigations applied to cultural heritage to preventive conservation (*The art under the microscope, Restoration between art and science, Diagnosis of the Beauty, Diagnostics applied to Cultural Heritage, From the art point of view*), to the state of preservation of the works of art (*Art Report*), to the dissemination of the conservation scientist skills in primary school (*Science at Work*): these are just some of the topics addressed during the trial of paths.

The tested model of cultural audience development allowed the CCR to deal with public and private institutions - museums, schools, associations, universities and research centers - to build a wider network of collaborations and a sensitive and attentive community. The discussion was also an opportunity to promote accessibility to laboratories for users with cognitive disabilities (*Anch'Io Centro!*) for an inclusion and participation point of view.

The poster presents the didactic activities for the school realized within the *Open for restorations* project, taking into account short and long term targets and aims. The teaching methodology adopted will be described, highlighting the actions of information and of the involvement of conservation experts and teachers as active subjects in the planning and implementation of activities.

"Cromlech" photogrammetric digital modeling of Passo Mandarini, Petralia Soprana (PA)

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In the last few years, during studies about Archaeology, the use of applied sciences has become useful. Among the applied sciences used on the field stands out Photogrammetry that is among the detection techniques that allows to obtain 3D digital surveys of areas and the geometric analysis of the evidence. The research always tries to find the simplest and economic techniques concentrate on the misuration and documentation of 3D models. The study of the areas to define their archaeological interest is a crucial phase for the preparatory study of the dig. Photogrammetry is a not- invasive technique that helps to find areas where there may be the existence of anthropic structures or other kind of structures, analysing in detail the site.
The paper purpose is to create a model accurate for the musealization and to describe the results of a preliminary interdisciplinary study for 3D modelling and for the analysis of the so-called "Cromlech " of Passo Mandarini in Petralia Soprana (PA). This present study wants to evaluate the creation of a 3D digital model of a semi-circle of a stone blocks useful for a better interpretation and understanding of the structure (Fig.1). The lithic complex is perfectly integrated with the surrounding environment and the outcropping rocks in the area. It Is so hardly to identify it from an untrained eye because of the difficulty to distinguish between the outcropping rocks and the anthropized rocks, on which previously a geological survey has been performed. Around a calcareous Mesozoic block in natural outcrop they have been identified some calcareous blocks at regular intervals. Their position is not attributable to natural geomorphological events but to anthropogenic events. The blocks are positioned on a small terrace and placed in a semicircle within which is detected the presence of a second smallest semicircle of blocks with same extension and volume. The area around the complex has probably undergone geomorphological changes due to small landslides that have changed the original architecture of the place.
Another objective of the paper is to describe all the steps in the documentation of the structure and to be able to give an interpretation of its use. In addition, the secondary purpose is the musealization of the 3D model of the so called "Cromlech " once its archaeological or geological value has been ascertained. The purpose of the present study will be the creation of a 3D model meticulously correct and similar to the real, functional and easy to visualize. The digital model gives us the opportunity to identify the Correctly alignment of the blocks and his nature for identify its possible structure and function. In particular, about the photogrammetric process it was interesting to use a photographic camera of average quality with objective 35mm.There have been many problems related because of the large dimensions of the complex and the difficulty to perform an relief through the use of camera from the ground , in fact, it was necessary use more chunks to obtain a complete relief of the structure .

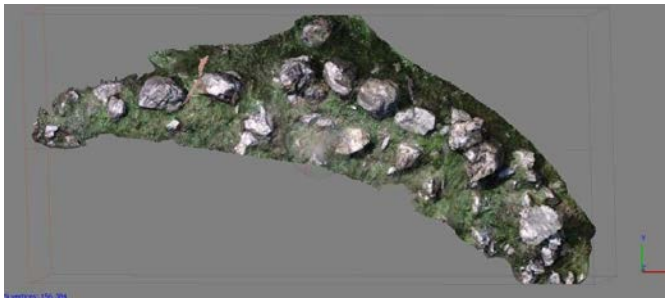

Fig 1. Orthophoto from 3d model of the “Cromlech” of Passo Mandarini, Petralia Sottana (PA).

3d survey and modeling of masks and calyx craters of Archaeological Museum of Lipari: integration of laser and photo scanning systems

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In the next few years, the traditional graphic documentation for cultural heritage will be destined to be replaced by three-dimensional digital models. These detailed representations will be deployed as tools for virtual fruition, monitoring of conservation status, recomposition and restoration activities.
The aim of this poster is to compare two of the most widely used surveying methodologies applied to archaeological heritage: laser scanning systems and controlled digital photogrammetry (or photo-scanning). The case of study concerns in particular some clay masks and two calyx craters preserved in the Regional Museum of Lipari "L. Bernabò Brea". The mobile artefacts have been scanned respectively by the use of a Faro laser arm (model *Cam2 Arm Quantum*) and photographic acquisitions (*Canon Eos 7D*) using a 'converging axes' schema, in order to get models not only geometrically accurate but also having a photorealistic rendering.
The poster will also provide an overview of the acquisition steps and will illustrate the workflow of the scans processing, carried out respectively through *Geomagic Wrap*, and *Agisoft Photoscan* (for the photographic data). Although the laser-scanner method is the most accurate and precise, there is however a poor (or absent) photorealistic rendering in relation to the high cost of equipments and elaboration softwares, which require as well long processing times and high modelling skills; the technique of photo-scanning, on the other hand, thanks to the *structure from motion algorithm* (*SfM*), allows, once the acquisition scheme is accurately designed, to partially automate the processes using low cost and user-friendly tools, having a less geometrical accuracy but providing a more effective photorealistic rendering.
The two methods, however, prove to be absolutely complementary, as will be demonstrated with the example of two craters: it is possible to integrate the dense cloud from laser-scanner with the photographic texture taken from the cameras to finally get an *integrated* model. The survey of the craters has also allowed to provide the Museum a projection on a plane of the decorative apparatus of the two vases and therefore a 3D documentation to be used for all the purposes described above and to introduce visitors to the new digital systems.

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A virtual approach to historical scientific instruments

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Nowadays the acquisition of 3D models of fragile and unique archaeological and historical pieces has become a routine activity. After the exhibition of ancient scientific instruments "La sapienza è figliola della sperienzia", held in Milano Bicocca University in 2015, we applied this technique to the most relevant available objects (mainly those coming from the Volta's laboratory), in order to build a virtual and interactive library where the functioning of the devices and their physical principles can be showed and exploited without involving any manipulation of the instruments. The 3D reconstruction was obtained by using 3D photogrammetry, acquiring the images with a Canon 100D camera. The dimensioned model was reconstructed using the Agisoft Photoscan and Meshlab software. The main challenge in this kind of measure is due to the presence of reflective surfaces, mainly those of brass and glass components, such as lenses and magnifiers. We succeeded in overcoming such difficulties by using a diffuse lighting to avoid reflections of direct light and spraying a layer of cyclododecane over the transparent parts to allow a detailed acquisition of their morphology.
The resulting models will be exploited in virtual exhibitions during scientific and didactics initiatives and *Open days* events and will be part of the "Progetto Lauree Scientifiche" and "Alternanza Scuola-Lavoro" to promote the dissemination of the scientific knowledge in secondary schools.

3D laser scanner techniques for the enhancement and virtual fruition of cultural heritage: the Church of Sant'Antonio Abate (RC)

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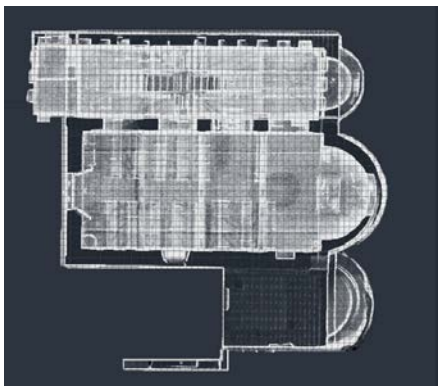
The Church of Sant'Antonio Abate is located in the Archi district, in the northern part of Reggio Calabria.

The first proof of the building's presence is known through two diplomas by Giovanna I D'Angiò, dating back to 1363, which prove the importance of the area, around which the important trade fair of Scaccioti gravitated. Between the end of the 15th and the beginning of the 16th century, due to the numerous turkish incursions into the territory, the church was severely damaged and gradually lost its importance following the change in commercial dynamics within the area.

The current building is therefore the result of a series of building phases attributable to a long chronological period dating from the 13th century to the 20th century, with the latest restoration works dating to the early Nineties. The surviving elements and peculiarities of the original architecture, ie the absence of a transept and the triabsidata plant with a longitudinal development with three naves, allow the church to be placed in the broader framework of the Byzantine-Norman building tradition.

The work carried out by the team of the IPCF-CNR of Messina has had as objective the realization of an updated survey of the structures and the consequent creation of a 3D model, which can be used virtually. The instrument used is a terrestrial laser scanner model FARO CAM2 Focus 3D S 120, with a field of view of 305 ° (vertical), 360 ° (horizontal) and a margin of error of ± 2 mm; 3D color and photorealistic scans were carried out, with a resolution of 70 mpx and color overlapping without parallaxes.



The architectural features of the building made it necessary to program twenty total scans of which eleven were performed outside the structure while the remaining nine were distributed sequentially inside the naves and the two crypts below the walkway.

The processing of the scans was performed through the integrated use of the dedicated software FARO SCENE v.18 and JRC 3D Reconstructor with which it was possible to proceed with the registration of point clouds, the creation of triangulated mesh and texturization of the model.

The model was subsequently exported to CAD for the construction of plants, sections and reconstructions of the building phases.

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The role of 3D modelling for different stone objects: from mineral to artefact

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Museums, in Italy and worldwide, big and small ones, are rich in findings of interest, many of whom are not always easily accessible, due to various reasons. More often it happens that many findings are stored in rooms with no public access, because the institution has no enough space to store them in the showrooms. New technologies and software developments are increasingly accessible, allowing a virtual approach to the exhibited findings. The use of 3D modelling can give a chance to see and "handle" different objects, like relics, artefacts, crystals, stones, statues, etc. without the need to be physically present in the museum or just to appreciate objects still stored by projecting their 3D images (Shcherbinin et al., 2018). 3D modelling of objects is based on the acquisition of multiple pictures both with common cameras and even the use of unmanned systems when a wider area is to be covered, and the use of a software for 3D modelling and reconstruction (Kesten et al., 2018; Monna et al., 2018). This study deals with the reconstruction and 3D modelling of different objects, with different sizes and shape complexities, belonging to different museums (naturalistic or with works of art) all around Tuscany.

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Geomatics techniques for cultural heritage dissemination in Augmented Reality: Bronzi di Riace case study

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The Riace Bronzes are two full-size bronzes cast about V century BC, located at the Museo Archeologico Nazionale della Magna Grecia in Reggio Calabria. Discovered in the coast of Riace Marina (RC) in 1972, they actually represent significant sculptural masterpieces of the Greek art in the world, thanks to their outstanding manufacture.
Modern digital fabrication techniques, such as photogrammetry and 3d printing enable new perspective in cultural heritage for maintenance and restoration. 3d scanning, photogrammetry, 3d printer and computer numerical control (CNC) technology united with low cost equipment offer the possibility to create a digital archive and low scale replicas of important monument and statue.
This paper describes the methodology for the realization of a 3D model of the two sculptures lead by the Geomatics Laboratory of the DICEAM of the Mediterranea University of Reggio Calabria. The 3D modelling is based on the use of imaging techniques, as digital photogrammetry and computer vision. The digital pictures obtained, with the authorization of the Ministry of Cultural Heritage and Activities and Tourism and of the Museo Archeologico Nazionale della Magna Grecia, have been then elaborated through commercial photogrammetry software. The results achieved denote the effectiveness of the technique used in the cultural heritage field, for the creation of a digital achieve and replication through 3d printing.
The renewed interest, in the context of international museological studies, for historical installations such as museographic devices capable of giving shape to a space duly dialoguing with the user, is due today to their communicative immediacy among the general public. In recent years the availability of libraries and tools for the use of augmented reality content has undergone an important increase. AR innovation represents a new method for enhancing visitors into the museum industry despite concerns over its return on investment. In this regard, in a wider work of valorisation and dissemination of archaeological heritage, we are working on the development of an app for tourism purposes. The app created (in Unity Enviroment) allows the user in real time, to have additional information on the object of the investigation, even to be able to view the 3D model in AR. He so makes a virtual tour inside (with a viewer or simply through the screen of the device), as well as being “accompanied” during the visit by a virtual guide that interacts with the surrounding environment. Scripts are associated to some of elements of the scenes (with or without graphic representation) which allow defining their behaviour thanks to the use of particular functions called event handlers.

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Submerged Heritage: Geomatics techniques and Augmented Reality

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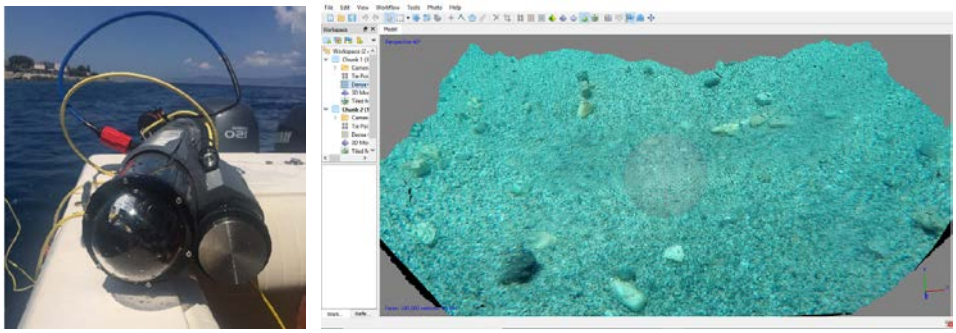
The Laboratory of Geomatica of the Mediterranean University of Reggio Calabria sets a goal to relive and re-propose the experience of a real immersion and the exciting moment of archaeological submerged discovery: an immersive journey in the interest of interactivity in virtual reality. Immersive Virtual Reality tries to combine the real and the virtual world, even involving our senses. In other words it allows us to enter into a scenery like the virtual reality one, but without being just a simple spectators. We become protagonists and we can participate and decide what to do and how to do it. Unity 3D is the multi-platform development environment used. We can configure the application either in visual mode (using its user interface) or by programming (using either the C # or Javascript language).
We obtained the scenarios and the objects included in the scene from three-dimensional models realized through photogrammetric techniques (seabed and artefact). As known, the direct underwater survey carried out by a human operator thought trilateration methodology (objective difficulty of the diver in maintaining a stable attitude) involves the use of a large amount of time (which is always limited in this environment) and an accentuated inaccuracy due to human errors. The Remote Operated Vehicles (ROVs) have been widely used in recent times by researchers to explore underwater environments, both in shallow and deep water, for different types of studies. The most innovative technologies of recent years have led to improve the quality of underwater surveys. They support the work of archaeologists even at depths where divers can work easily but with reduced immersion times. The ROVs , if assembled with cameras, could make a survey photogrammetric in a single dive thanks to the high battery's life. For this reason the seabed was detected through the aid of an experimental ROV (realized in a broader project of agreement with the IPCF CNR Messina). A grid of known dimensions assisted the ROV's use in order to correct the effects of distortion effects obtained in water. The proposed app is still being perfected and completed.



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Technologies at the service of promotion. 3d modeling, virtual restoration and augmented reality applied to MArRC's collection.

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In the last few years, Science, Art and Education had to rearrange their communication strategies in relation to the demands of a public increasingly attracted by the potential offered by new IT. The development and the application of these technologies in the field of Cultural Heritage has introduced new horizons in terms of research, preservation, monitoring of conservation status, restoration activities, promotion, interactive fruition and accessibility also within the Museums.

In this poster will be presented the results of 3d rendering and augmented reality application, results of the collaboration between the National Archaeological Museum of Reggio Calabria (MArRC) and the IPCF-CNR of Messina. With the aim of making the MarRC collection much more accessible, interactive and in line with the new visitors needs, have been created new interactive and informative contents from 3d models of artifacts easily viewable on portable personal devices (smartphones, tablets) or other multimedia supports.

On the occasion of the day Arte e scienza, organized by the Italian Association of Archaeometry (AIAr), the team of the IPCF-CNR institute of Messina created a textured three-dimensional model of a leonine protome from Hipponion (Vibo Valentia) and kept at the national archaeological museum of Reggio Calabria.

Scans were performed through the use of the "Freestyle" portable laser scanner of the FARO company with single-point precision ≤ 1.0mm. Photo sockets were then taken on the exhibit for the realization of the texture to be applied to the point cloud.

Point cloud processing has been performed with dedicated Geomagic wrap and 3D Zephyr software. The model, once realized the triangulated mesh has been texturized. an animated rendering of the exhibit has been realized for a better visualization.

These technologies not only represent a step forward in terms of fruition but also an opportunity for analysis and diagnostic: virtual models can be used as important basic tools to advance hypotheses of reconstruction and to analyze methods and techniques of ancient productions. The communicative effectiveness of these models can be much more enhanced if inserted in a context of augmented reality that provides an overlap between the representation of real elements and additional virtual information layers (as digital 2d or 3d returns).

Finally the application of these technologies to MArRC's collection has proved to be useful for several reasons: 1. to make accessible objects stored in the museum warehouses; 2. to allow the visitor to better enjoy their experience of fruition, not simply by looking at them through a glass, but having the opportunity to interact with artifacts; 3. to provide the visitor the exact original conformation of a find (a digital reconstructive hypotheses), without intervening directly on it and preserving its integrity.

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Agostino, Raffaele Giuseppe	C&D15, C&D19
Albano, Michela	PD&TV05, P12
Alberghina, Maria Francesca	C&D08, C&D13, CMR05, P02, P08
Alberghina, Filippo	C&D08
Albertin, Fauzia	LM02
Alessandri, Luca	PD&TV06
Alfano, Giovanni	PD&TV01
Aliotta, Francesco	PS03, P30
Altieri, Simona	P11
Amadori, Maria Letizia	DBC02
Anastasio, Gianfranco	C&D08, P08, P15
Angelici, Debora	P14
Angelini, Emma	C&D20
Aquino, Andrea	C&D10, P22, P28
Arcovito, Armando	C&D24
Arcudi, Anna	C&D09, CMR02
Arienzo, Ilenia	PD&TV06
Armetta, Francesco	MC02
Armone, Giulia	DR04
Artioli, Gilberto	P10
Auricchio, Teodoro	LM03
Barca, Donatella	PD&TV04, P01
Barone, Serena	MC01
Barrile, Vincenzo	P27, P29, P30
Bartolozzi, Giovanni	C&D13, LM01
Belluso, Elena	P10
Berrettoni, Mario	MC02
Bersani, Danilo	P12
Bertasa, Moira	P13
Bertoni, Duccio	P21
Bettuzzi, Matteo	LM02
Biondo, Stefano	PD&TV01
Birarda, Giovanni	P11
Bloise, Andrea	PD&TV04
Blümich, Bernhard	P12
Boano, Rosa	P14
Boesso, Sandra	P10
Bonaduce, Ilaria	C&D04
Bonanno, Sara	DR01, P15, P27, P31
Borla, Matilde	P14

NOME AUTORE	CODICE CONTRIBUTO
Bracci, Susanna	C&D13, LM01, P03
Branca, Caterina	C&D24
Brancaccio, Rosa	LM02
Brizi, Leonardo	CMR04
Bruni, Simone	C&D03
Bruno, Fabio	DBC04, PS01
Buccolieri, Giovanni	PD&TV02
Buccolieri, Alessandro	PD&TV02
Burrascano, Pietro	C&D23
Buscaglia, Paola	C&D05, C&D14
Caccamo, Maria Teresa	P20
Caggiani, Maria Cristina	C&D06, P07
Caglio, Simone	P05
Cagnato, Clarissa	P11
Caliri, Claudia	C&D05, C&D14
Cammalleri, Angelo	P24
Candela, Gabriele	P29
Caponetti, Eugenio	MC02, P04, P15
Cappa, Marco	PD&TV04
Cappello, Francesco	PD&TV01
Cardiano, Paola	C&D22
Cardinali, Michela	P23
Carlucci, Davide	P10
Carnazza, Paola	C&D04
Carnelli, Alice	DR03
Casali, Franco	LM02
Casini, Andrea	C&D14
Castellà, Maria Florencia	MC01
Castellano, Alfredo	PD&TV02
Cavaleri, Tiziana	C&D05
Cavalieri, Marco	P03
Cefarin, Nicola	P11
Cestelli Guidi, Mariangela	C&D01
Chelazzi, David	MC01
Ciaramitaro, Veronica	P04
Cilenti, Francesca	P09
Cintura, Federica	PD&TV06
Colao, Francesco	C&D01
Collina, Alessandra	P05
Colombini, Maria Perla	C&D04
Coniglio, Lara	P23
Conti, Paolo	MC02
Corradini, Martina	P07
Cortese, Francesca	PD&TV06
Cosio, Emanuele	C&D24
Covalenco, Serghei	P11
Cozza, Marco	PS01

NOME AUTORE	CODICE CONTRIBUTO
Crespi, Arianna	DR03
Croveri, Paola	P13
Cucci, Costanza	C&D14
Damiani, Laura	C&D08
Dan, Roberto	C&D11
D'Andrea, Maria	P01
D'Angelo, Giovanna	C&D24
Davidde Petriaggi, Barbara	DBC04, PS01, PS02
De Angelis, Flavio	PD&TV06
De Angelis, Daniela	PD&TV04
De Caro, Tilde	C&D20
De Ferri, Lavinia	P07
De Luca, Raffaella	PD&TV04
De Luca, Daphne	C&D04
De Paoli, Michela	CMR01
D'Elia, Elena	C&D14
Devidze, Marina	C&D07
Di Bella, Marcella	P18
Di Giacomo, Caterina	C&D08, P08
Di Vito, Mauro	PD&TV06
Donato, Eugenio	DR02
Edge, David	C&D21
Eliazian, Gavane	P17
Emanuele, Lucia	C&D19
Enei, Flavio	PS02
Ercoli, Laura	P04
Es Sebar, Leila	C&D20
Facchinetti, Francesca	C&D05
Fanfani, Veronica	MC01
Fantino, Fulvio	P10
Fazzari, Barbara	DBC02
Fedele, Giuseppe	PD&TV04
Fedi, Mariaelena	MC01
Ferrarato, Bianca	P14
Ferrarese, Silvia	P21
Ferrari Trecate, Massimo	P05
Ferraris, Enrico	C&D05, DBC01
Ferraris di Celle, Gianna	P14
Filosa, Raffaele	C&D15, C&D19
Fiocco, Giacomo	PD&TV05, P12
Fiorenza, Elia	P01
Formoso, Vincenzo	C&D15, C&D19
Fornacelli, Cristina	P03
Fotia, Antonino	P27, P29, P30
Fratini, Fabio	CMR01
Furnari, Giuseppe	LM04
Furno, Antonella	P09
Gallace, Alessio	PD&TV04

NOME AUTORE	CODICE CONTRIBUTO
Galli, Anna	DBC03, P06, P26
Gallo, Paolo	P14
Gargano, Marco	C&D05, DR03
Gattuso, Caterina	C&D27
Germinario, Chiara	C&D12, C&D13, C&D26, P09
Giacobello, Fausta	P08
Giamello, Marco	P03
Giancarlo, Niceforo	C&D19
Giannossa, Lorena Carla	C&D06
Giarrusso, Sebastiano	MC02
Giuffrida, Dario	DR02, P16, P25, P31
Giuntini, Lorenzo	C&D21
Gomez Laserna, Olivia	C&D22
Grassini, Sabrina	C&D20
Grazzi, Francesco	C&D21
Greco, Christian	P14
Gregorio, Valeria	C&D22
Grifa, Celestino	C&D12, C&D13, C&D26, P09
Grifoni, Emanuela	DR03
Gueli, Anna, Maria	LM04
Guidorzi, Laura	P10
Gulmini, Monica	C&D14, PD&TV05, P13, P14
Iannaccone, Roberta	LM01
Impallaria, Anna	C&D03
Interdonato, Monica	C&D24
Invernizzi, Claudia	PD&TV05, P12
Italiano, Francesco	P18
Iwanicka, Magdalena	P12
Izzo, Francesco	C&D13, P09
Keheyan, Yeghis	C&D11, P17
La Felice, Sonia	C&D07, C&D10, P22
La Nasa, Jacopo	C&D04
La Russa, Daniele	PS02
La Russa, Mauro	C&D09, C&D13, DBC04, PS02
La Torre, Leonardo	P10
Lagioia, Giovanni	C&D06
Landi, Simone	P22
Landi, Stefano	P03
Lando, Gabriele	C&D22
Langella, Alessio	P09
Lankani, Weththimuni	C&D09
Maduka Lanterna, Giancarlo	C&D11
Laureti, Stefano	C&D23
Lazzarini, Lorenzo	PD&TV01
Le Pera, Emilia	C&D09
Lenzi, Sara	LM01

NOME AUTORE	CODICE CONTRIBUTO
Leone, Marcella	C&D12, P21
Lezzerini, Marco	C&D10, P22, P28
Licchelli, Maurizio	C&D09, PD&TV05, P12
Liccioli, Lucia	MC01
Liverani, Paolo	LM01
Livio, Chiara	P05
Lo Giudice, Alessandro	P10, P14
Lombardo, Domenico	P20
Longo, Laura	P11
Loreggian, Diego	DBC02
Lottici, Pier, Paolo	P12
Lubritto, Carmine	C&D13, CMR05, P11
Łucejko, Jeannette Jacqueline	C&D17
Lucero, Paola	CMR03
Lucia, Vincenzo	CMR01
Ludwig, Nicola	DR03
Lupò, Giuseppe	P08
Luvidi, Loredana	CMR01
Macchia, Andrea	C&D09
Magazù, Salvatore	P20
Magrini, Donata	C&D13, CMR01, LM01
Makris, Theodoros	DBC04
Malacrino, Carmelo	PD&TV03, P31
Malagodi, Marco	PD&TV05, P12
Malekmohammadi, Hamed	C&D23
Manganelli Del Fa, Rachele	CMR01
Mangone, Annarosa	C&D06
Maniccia, Eleonora	C&D04
Maniscalco, Laura	C&D25
Manna, Daniela	P03
Mannuccia, Francesco	PD&TV01
Mantella, Giuseppe	PD&TV03
Manzini, Davide	P07
Marazzi, Massimiliano	C&D26
Marinelli, Marco	C&D01
Marte, Fernando	MC01
Martini, Marco	DBC03, P06, P26
Martire, Luca	P10
Masiello, Antonio	CMR05
Maspero, Francesco	DBC03, P26
Massa, Emanuela	C&D13
Mastelloni, Maria Amalia	P16, P18, P25
McQueen, Caitlin	C&D17
Mercurio, Mariano	C&D13, P09
Micieli, Davide	PD&TV04
Milazzo, Giuseppe	PD&TV01
Miliani, Costanza	C&D04, LM05

NOME AUTORE	CODICE CONTRIBUTO
Milotta, Filippo Luigi Maria	LM04
Miriello, Domenico	PD&TV04
Mittica, Gloria	C&D15
Modugno, Francesca	C&D04
Moggi Cecchi, Vanni	P28
Mollica Nardo, Viviana	C&D13, P08, P15, P16, P19, P25
Moretti, Patrizia	C&D04
Morigi, Maria, Pia	LM02
Morini, Pierangelo	C&D16
Morra, Vincenzo	C&D12, C&D26
Mostacci, Miranda	C&D23
Munzi, Priscilla	C&D12
Muraca, Pietro Maria	PD&TV04
Musella, Marianna	P01
Muto, Francesco	PD&TV04
Niceforo, Giancarlo	C&D15
Nunnari, Antonino	P27
Obada, Théodor	P11
Oddo, Maria Emanuela	C&D13
Onuki, Yusuke	C&D21
Pafumi, Stefania	C&D18
Pagnotta, Stefano	C&D13
Panzeri, Laura	DBC03, P26
Pappalardo, Lighea	C&D18
Parrotta, Francesco	P15, P27
Parvis, Marco	C&D20
Pasquale, Stefania	LM04
Pecchioni, Elena	P28
Pellegrino, Daniela	PS02
Pellegrino, Lorella	C&D08, PD&TV01
Peruzzo, Luca	P10
Petrosyan, Artur	C&D11
Petrucci, Ferruccio	C&D03
Piccirillo, Anna	C&D14, P14, P23
Picollo, Federico	P10
Picollo, Marcello	C&D14
Piluso, Eugenio	PD&TV04
Pisarra, Damiano	C&D19
Pizzimenti, Silvia	C&D04
Pojana, Giulio	C&D06, P07
Ponterio, Rosina Celeste	C&D13, PS03, P15, P16, P19, P25, P27, P30, P31
Prestileo, Fernanda	CMR01
Principe, Claudia	C&D07, C&D10, P22
Pronti, Lucilla	C&D01
Pucino, Francesco	PD&TV04
Pugliese, Paolo	PD&TV04

NOME AUTORE	CODICE CONTRIBUTO
Quartieri, Simona	P18
Quattrocchi, Camillo	LM04
Racca, Gessica	P14
Raffiotta, Serena	C&D02, P02
Raimondo, Luisa	P06
Randazzo, Luciana	C&D09, PS02
Raxis, Polivios	DBC04
Re, Alessandro	C&D20, P10, P14
Rehorn, Christian	P12
Renda, Vincenzo	P16, P19
Repola, Leopoldo	C&D26
Ricca, Michela	C&D09, PS02
Ricci, Marco	C&D23
Ricci, Chiara	P13, P23
Ricci, Paola	C&D13, P11
Richards, Olga	PD&TV06
Rigato, Valentino	P10
Riminesi, Cristiano	CMR01
Rinaudo, Marta	P21
Ripoli, Giacomo	PD&TV04
Rizwan, Khalid	C&D23
Rolfo, Mario, Federico	PD&TV06
Romani, Martina	C&D01
Romano, Francesco Paolo	C&D05, C&D14, C&D18
Romboni, Marco	PD&TV06
Rovella, Natalia	C&D09, C&D13, DBC04, PS02
Rovetta, Tommaso	PD&TV05, P12
Ruffolo, Silvestro Antonio	C&D09, C&D13
Sabatino, Giuseppe	C&D24, P18
Sahlstedt, Malin	C&D17
Saija, Franz	P08
Saladino, Maria Luisa	P04, P08, P15
Salerno, Giuseppe	C&D08
Salerno, Ruggero	C&D08
Sali, Diego	C&D16
Santaniello, Gianluca	PD&TV04
Sassella, Adele	P06, P26
Scalarone, Dominique	P13
Schachner, Andreas	C&D26
Scherillo, Antonella	C&D21, MC02
Schiavone, Salvatore	C&D08, C&D13, CMR05, P08
Schillinger, Burkhard	C&D21
Serra, Antonio	PD&TV02
Sevink, Jan	PD&TV06
Sfarra, Stefano	C&D23
Sibilia, Emanuela	DBC03, P26
Skakun, Natalia	P11

NOME AUTORE	CODICE CONTRIBUTO
Skarlatos, Dimitrios	PS01
Smeriglio, Andrea	C&D15, C&D19
Sorci, Adelmo	MC02
Sorrentino, Germana	P11
Spagnuolo, Antonio	CMR05
Spinella, Alberto	P04
Stanco, Filippo	LM04
Stefani, Lorenzo	C&D14
Stringhetti, Federica	P05
Sudano, Fabrizio	P01
Taliano Grasso, Armando	C&D19, P01
Tanasi, Davide	LM04
Taranto, Mirco	PD&TV04
Targowski, Piotr	P12
Terekhina, Vera	P11
Tomaciello, Laura	PD&TV04
Tortora, Luca	P11
Toscano Raffa, Alessio	C&D22, DR01
Tripodo, Alessandro	P18
Tropea, Mauro	PD&TV04
Trusso, Sebastiano	P19
Tusa, Sebastiano	PD&TV01, P18
Vaccari, Lisa	P11
Vacirca, Ivana	C&D25, P31
Valazza, Alberto	P14
Vasi, Cirino Salvatore	PS03, P15
Verona Rinati, Gianluca	C&D01
Vetromile, Carmela	CMR05
Viel, Selena	P23
Vitolo, Priscilla	C&D11
Wanderlingh, Ulderico	C&D24
Williams, Alan	C&D21
Yivlialin, Rossella	P06
Zamponi, Silvia	MC02
Zuchtriegel, Gabriel	C&D13